

Alternative Fuel Petitions Program

Sample Petition

Submitted to the U.S. Department of Energy by Pure Energy, 1997-1998



PureEnergy™

Pure Energy Corporation
One World Trade Center
Suite 4573
New York, New York 10048
tel 212.938.6923
fax 212.839.0383

June 30, 1997

The Honorable Federico F. Peña
Secretary
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Mr. Secretary:

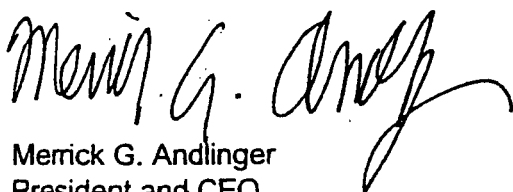
I am pleased to enclose Pure Energy Corporation's petition seeking a rulemaking to designate our proprietary alternative motor fuel as an "alternative fuel" under Section 301(2) of the Energy Policy Act of 1992.

Our fuel is a unique blend of ethanol, pentanes plus and methyltetrahydrofuran. Both ethanol and MTHF will be derived from renewable resources, i.e., waste cellulosic biomass such as waste paper, agricultural waste and urban/industrial wood waste. If the pentanes plus are obtained as expected from natural gas liquids, the fuel will be entirely non-petroleum and as much as 70% renewable.

Our fuel has substantial environmental benefits relative to gasoline in that it produces significantly less emissions, including greenhouse gases, when run in automobiles. The production process is also less intensive than that of gasoline.

We respectfully seek prompt consideration of our request, as we believe prompt commercialization and development of our fuel is in the national interest.

Very truly yours,


Merrick G. Andlinger
President and CEO

MGA/dd

Enclosure

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063097

Docket Number: EE-RM-98-PURE

PureEnergy



Pure Energy Corporation
One World Trade Center
Suite 4573
New York, New York 10048
tel 212.938.6923
fax 212.839.0383

PETITION FOR RULEMAKING

TO DESIGNATE A PROPRIETARY FUEL MIXTURE
AS AN 'ALTERNATIVE FUEL'
UNDER SECTION 301(2) OF THE ENERGY POLICY ACT OF 1992

PRESENTED TO THE U.S. DEPARTMENT OF ENERGY
OFFICE OF GENERAL COUNSEL

BY:
PURE ENERGY CORPORATION
Merrick G. Andlinger, President and Chief Executive Officer

June 30, 1997

SUMMARY:

Section 301(2) of the Energy Policy Act of 1992 (EPACT) provides that "the term 'alternative fuel' means [certain specified fuels and] ... any other fuel the Secretary determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits."¹

The purpose of this petition is to request the Secretary to initiate a rulemaking determining that the proprietary alternative fuel blend developed by Pure Energy Corporation (Pure) meets the criteria set forth in the law and is therefore found to be an "alternative fuel" under the law and implementing regulations.

The Pure fuel is a unique blend of ethanol, pentanes plus, and a co-solvent, methyltetrahydrofuran (MTHF), in roughly equal parts, plus butane in severe cold-weather conditions. Both the ethanol and the co-solvent will be derived from renewable resources – e.g., waste cellulosic biomass, such as waste paper, agricultural waste, and urban/industrial wood waste. If the pentanes plus are obtained as expected from natural gas liquids, the fuel will be entirely non-petroleum in nature and as much as 70 percent renewable.

INSERT #1

Use of this fuel in new and existing flexible-fuel vehicles will have substantial benefits for energy security, by reducing U.S. dependence on imported oil; for the environment, by reducing hydrocarbon and greenhouse gas emissions; and for the economy, by creating new jobs and reducing the trade deficit. Prompt commercialization and deployment of the Pure fuel is in the national interest.

¹ Energy Policy Act of 1992, Public Law 102-486, codified at 42 U.S.C. 13211(2).

I. BACKGROUND AND HISTORY

The provisions of the Energy Policy Act of 1992 relevant to this petition were drafted in the House Energy and Commerce Committee, which stated the following "purpose and summary" when it reported H.R. 776 on a vote of 42-1:

The purpose of H.R. 776 is to enact a comprehensive national energy policy that gradually and steadily increases U.S. energy security in cost-effective and environmentally beneficial ways.

The bill seeks to reduce the costly, impending rise in U.S. oil imports; to conserve energy and use it more efficiently; to reduce our use of oil-based fuels in our motor vehicle sector; to increase competition in the electricity, natural gas, coal, renewable energy, and oil markets in order to provide new energy options and more diverse supplies; to increase the strategic oil reserves that shield us from another world oil disruption; to implement solutions to our nuclear waste and uranium enrichment problems; and to address greenhouse warming.²

Those objectives are meant to cover the entire range of energy policy; nonetheless, the development of the Pure fuel responds directly to four of the seven challenges – reducing oil imports; reducing the use of oil-based transportation fuels; increasing competition and providing new energy options; and addressing greenhouse warming.

The conditions that led to passage of EPACT in 1992 are even more acute today. In 1996, declining U.S. crude oil production and higher demand resulted in an average 8.4 million barrels per day of total petroleum net imports, just below the record 8.6 million barrels per day set in 1977. In 1997, total net imports are projected to exceed 1977's record high, equaling 48.5 percent of total petroleum demand in the EIA base case on an annual basis, and rising to 49.6 percent in 1998.³

General Lee Butler, U.S.A.F. (ret.), former Director of Strategic Plans and Policy for the nation's armed forces, addressed this issue powerfully before a Senate hearing in October 1996. He said:

It is instructive to recall that when mandatory oil import quotas were first imposed in 1959, this highly controversial measure was prompted by the security implications of a dependency on foreign imports that had grown to the alarming level of 18 percent. Today that figure has passed 50 percent and may well reach 60 percent early in the next decade. For a strategic planner, this defies imagination, especially given the painful lessons and enormous price such dependency has already levied. This is a reckless abdication of responsibility and acquiescence to market forces effectively beyond our control. The lure and the

² House Report No. 102-274(I), p. 132.

³ "U.S. Oil Demand," Energy Information Administration, U.S. Department of Energy, *Short-Term Energy Outlook*, Second Quarter, 1997 Edition.

illusion of low gasoline prices has lulled us into placing our economic security in jeopardy, our military forces at risk and our leadership in question.⁴

Titles III, IV, and V of the Energy Policy Act of 1992 seek to encourage the development of alternative fuels and alternative fueled vehicles through a mixture of incentives and mandates. The objectives, as the definition of "alternative fuel" makes clear, are twofold: "substantial energy security benefits and substantial environmental benefits."

The complete wording of Section 301(2) is as follows: "the term 'alternative fuel' means methanol, denatured ethanol, and other alcohols; mixtures containing 85 percent or more (or such other percentage, but not less than 70 percent, as determined by the Secretary, by rule, to provide for requirements relating to cold start, safety, or vehicle functions) by volume of methanol, denatured ethanol, and other alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; coal-derived liquid fuels; fuels (other than alcohol) derived from biological materials; electricity (including electricity from solar energy); and any other fuel the Secretary determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits."⁵

Explaining that final clause, the House Energy and Commerce Committee reported that it had "provided the Secretary with the opportunity to add alternative and replacement fuels that are not now being marketed to those specifically identified in the legislation.... Of course, in order to provide competitive opportunities the Committee does not want any rulemaking under this section to result in preventing new fuels from qualifying as alternative fuels."⁶

On March 14, 1996, the U.S. Department of Energy promulgated a final rule for the Alternative Fuel Transportation Program, implementing the EPACT provisions relating to the acquisition of alternative fueled vehicles by alternative fuel providers and state government fleets. The definition contained therein was slightly different from the one in EPACT: "*Alternative fuel* means methanol, denatured ethanol, and other alcohols; mixtures containing 85 percent or more by volume of methanol, denatured ethanol, and other alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; coal-derived liquid fuels; fuels (other than alcohol) derived from biological materials; and electricity (including electricity from solar energy)."⁷

The variation in wording can be seen as simply omitting – for the purpose of that particular rulemaking – the clauses that provide discretion to the Secretary. As will be shown below, the Pure fuel qualifies as an alternative fuel under EPACT – as a fuel that "is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits," and should be treated as such under the Alternative Fuel Transportation Program.

⁴ Testimony of General Lee Butler, United States Air Force, retired, before the Senate Committee on Agriculture, Nutrition and Forestry, on *Renewable Fuels and the Future Security of U.S. Energy Supplies*, Washington, D.C., October 2, 1996.

⁵ Energy Policy Act of 1992, Public Law 102-486, codified at 42 U.S.C. 13211(2).

⁶ House Report No. 102-274(I), p. 182.

⁷ *Federal Register*, Vol. 61, No. 51, March 14, 1996, p. 10622 et seq.

II. EPACT CREATES A CRITICAL MARKET FOR ALTERNATIVE FUELS

Under EPACT, by the year 2001, 75 percent of all affected federal and state government vehicle purchases, and 90 percent of all affected vehicle purchases by private alternative fuel suppliers (mostly utilities), must be AFVs. These requirements will begin in 1997 and will affect centrally fueled fleets with 20 or more light-duty vehicles (less than 8500 lbs) that operate in major urban areas.⁸

On April 21, 1993, just a few months into his first term, President Clinton demonstrated his commitment to fulfilling the EPACT mandates for alternative fuel vehicles in the federal fleet by issuing Executive Order 12844, "Federal Use Of Alternative Fueled Vehicles," which stated: "The Federal Government can exercise leadership in the use of alternative fueled vehicles. To that end, each agency shall adopt aggressive plans to substantially exceed the alternative fueled vehicle purchase requirements established by the Energy Policy Act of 1992."⁹

This position was reaffirmed last year when the President issued Executive Order 13031, "Federal Alternative Fueled Vehicle Leadership." This order, which superseded its predecessor, stated:

[T]he use of alternative fueled motor vehicles will, in many applications, reduce the Nation's dependence on oil, and may create jobs by providing an economic stimulus for domestic industry, and may improve the Nation's air quality by reducing pollutants in the atmosphere.... The purpose of this order is to ensure that the Federal Government exercise leadership in the use of alternative fueled vehicles (AFVs). To that end, each Federal agency shall develop and implement aggressive plans to fulfill the alternative fueled vehicle acquisition requirements established by the Act.... To the extent practicable, agencies shall use alternative fuels in all vehicles capable of using them.¹⁰

While EPACT currently affects only fleet vehicle purchases by the federal government, state governments, and private alternative fuel suppliers, the Department of Energy has the authority to propose further regulations to extend AFV purchase requirements to local governments and other corporate fleets in the near future. EPACT sets goals of a 10 percent displacement in U.S. motor fuel consumption by the year 2000 and a 30 percent displacement by the year 2010 through the production and increased use of replacement fuels.¹¹

Even though the direct legal impact of designating the Pure fuel as an alternative fuel under EPACT will only impact the programs implemented by the Department of Energy, other federal programs, as well as state and local alternative fuel programs, look to the Department for leadership in determining which fuels should be considered as alternative fuels. Thus, designation

⁸ *Federal Register*, Vol. 61, No. 51, March 14, 1996, p. 10622 et seq.

⁹ Executive Order 12844, "Federal Use of Alternative Fueled Vehicles," April 21, 1993.

¹⁰ Executive Order 13031, "Federal Alternative Fueled Vehicle Leadership," December 13, 1996.

¹¹ Energy Policy Act of 1992, Section 502, codified at 42 U.S.C. 13252.

of the Pure fuel as an alternative fuel will allow for greater flexibility in meeting the requirements of multiple federal, state, and local government environmental or alternative fuel programs.

For example, the Congestion Mitigation Air Quality Program provides financial assistance for innovative programs that promise to improve traffic congestion and air quality. Established by the Clean Air Act Amendments of 1990, the program is managed by the Federal Highway Administration and the Federal Transit Administration. The provision of grants to local governments to adopt alternative fuel technology has been one of the most successful applications of program funds, yet these agencies generally rely on guidance from the Department of Energy to determine whether a particular fuel or vehicle type should qualify for support as part of an alternative fuel proposal.

Similarly, many state governments have their own alternative fuel programs, with varying objectives and approaches, but most still use federal standards to define the eligible fuels. Thus, the Department's treatment of a candidate alternative fuel under EPACT will have far-reaching ramifications on other state and federal programs.

III. CHARACTERISTICS OF THE FUEL AND MARKET ENTRY STRATEGY

The Pure fuel will be produced by blending ethanol and MTHF derived from cellulosic biomass with pentanes plus (expected to be derived from natural gas liquids). To produce the ethanol/MTHF blend, the company expects to use an acid hydrolysis process and is exploring a variety of refinements and other options for the economic conversion of low-cost feedstocks to ethanol and other chemicals. MTHF is currently produced in limited quantities from furfural (derived from both biomass and petroleum feedstocks) for use as a specialty chemical in consumer end products and/or process industries. The present furfural/maleic anhydride pathways that are commercially used to produce MTHF for chemical use are uneconomical for the production of transportation fuel. The company is developing a novel thermochemical technology to produce MTHF from cellulosic feedstocks through a levulinic acid pathway, integrating it with an ethanol production system to achieve optimum technical and economic efficiencies. (A schematic diagram of the pathways to the Pure fuel is provided at Appendix D.)

The integrated production schemes utilize commercially proven concentrated acid hydrolysis processing as its base technology. The lignocellulosic feedstock is converted into both five- and six-carbon sugars, which are then bifurcated into fermentation and thermochemical pathways to produce ethanol and MTHF, respectively. The integrated ethanol/MTHF system shares all water, steam, electricity, process chemicals, and both upstream and downstream processing needs, reducing operating and capital costs while maximizing feedstock utilization efficiencies. The company also is continuing research and development efforts to determine whether precursors or co-product chemicals of MTHF will prove to be superior cosolvents.

Pure expects to price its fuel competitively – initially with other alternative fuels and eventually with gasoline. The company proposes to vary the components of its fuels to meet particular

market demands. The fuel blends described below are intended to represent options within possible blending ranges – of pentanes plus, from 10 percent to 50 percent by volume; MTHF, from 15 percent to 55 percent; ethanol, from 25 percent to 55 percent; and butane, from zero to 15 percent.

These blends – characterized as regular, premium, and cold-weather – have been analyzed and tested to address the issues raised by this petition:

(percentage by volume)

	Reg.	Prem.	Cold
Pentanes plus	32.5%	27.5%	16.0%
MTHF	32.5%	17.5%	26.0%
Ethanol	35.0%	55.0%	47.0%
N-butane			11.0%

Pure Energy Corporation is entirely owned and financed privately. The Pure fuel is being developed on the basis of research performed at Princeton University. Princeton's patent application for the fuel has been allowed, and Princeton has licensed the rights exclusively to Pure.

The company's strategy is to serve state and federal fleet customers initially and then reach out to a broader segment of the motoring public. By 2001, the Energy Policy Act of 1992 requires that 75 percent of the light-duty vehicles acquired for federal and state fleets be "alternative fueled vehicles,"¹² and by this petition the company seeks designation of its fuel as an alternative fuel for this purpose. Similarly, the Clean Air Act's requirements have led California and the Northeastern states to set very aggressive mandates for the sale of "clean fuel vehicles," and Pure will seek to qualify certain vehicles for this purpose when operated on its fuel. The emissions characteristics of the fuel are described more fully below and in Appendix C.

The geographic availability of the three components of the Pure fuel, as well as the proximity of market opportunities, will initially help to define the fuel's niche relative to competing fuels. Pure has entered into an agreement with Arkenol Holdings, a bio-refining company, to design, construct and operate a pilot plant for the production of the bio-based components of the fuel in California.

The cost of producing ethanol from cellulosic biomass, a process that partially underlies the company's cost projections for its fuel, is expected to decline rapidly from its current level of \$1.22/gallon to approximately 67 cents.¹³ One analysis goes so far as to project a cost of 50 cents per gallon for a mature biofuels industry and 34 cents for a "best-parameter" scenario.¹⁴

¹² *Federal Register*, Vol. 61, No. 51, March 14, 1996, p. 10656.

¹³ Charles E. Wyman, National Renewable Energy Laboratory, "Ethanol from Lignocellulosic Biomass: Technology, Economics, and Opportunities," *Bioresource Technology* 50 (1994), pp. 3-16.

¹⁴ Lee R. Lynd, Richard T. Elander, and Charles E. Wyman, "Likely Features and Costs of Mature Biomass Ethanol Technology," *Applied Biochemistry and Biotechnology*, Vol. 57/58, 1996.

The Pure fuel can be expected to compete on value as well as price. In addition to the benefits it offers in terms of energy supply and environmental impacts, it has excellent performance characteristics as well.

Based upon results expected from its pilot plant project, Pure Energy Corporation is prepared to raise private financing for the construction of the first major ethanol/MTHF plant in the world and to move forward with still greater expenditures once proof of concept and engineering scale-up is complete. The company is prepared to work cooperatively with the Department of Energy on this project, which is expected to demonstrate and/or result in important advances in the production of ethanol and MTHF from cellulosic biomass. The company's access to the capital needed for this and later projects will be enhanced by an early determination by the Department that the Pure fuel does in fact qualify as an alternative fuel under EPACT.

IV. IMPACT ON VEHICLE MARKET

Because of the Pure fuel's ethanol fraction, it is best used in flexible-fuel vehicles (FFVs) that are designed to handle any combination of gasoline and alcohol fuels. Development and testing of the fuel was carried out first on a standard 1996 Ford Taurus E-85 FFV after consultation with Ford engineers and later on two standard 1997 Ford Taurus E-85 FFVs without any modifications.

As these tests demonstrated, existing FFVs will operate on the Pure fuel without change. In addition, M-85 FFVs can be easily adapted, providing another option for states like California that have invested in those vehicles. This market opportunity for the Pure fuel was bolstered by recent announcements by Chrysler and Ford that they are planning to mass-produce hundreds of thousands of FFVs and sell them to the public as conventional light-duty vehicles. Pure does not intend to market the fuel for sale in vehicles designed solely for gasoline use.

Successful commercialization of the Pure fuel, to meet the demand created by these FFVs, will enhance the market for ethanol – both as a component of the Pure fuel and as a neat fuel in its own right – because it will encourage the further growth of a refueling infrastructure that is compatible with ethanol. As a liquid, the Pure fuel can be easily accommodated within the existing transportation fuel distribution system in the same way that ethanol has been already.

Development of this refueling infrastructure – spurred by the availability of FFVs and a competitive Pure fuel – will be the final step toward solving the so-called “chicken and egg” problem that has bedeviled alternative fuel development from the beginning: Consumers won't buy vehicles that they can't refuel, and service stations won't stock fuel for vehicles that don't exist. A growing infrastructure will make it much easier for state and local government agencies to meet their requirements under EPACT to acquire alternative fuel vehicles for their fleets (and to use alternative fuels in those fleets), and like a snowball rolling downhill, these developments will build on each other until a fully competitive national market for the Pure fuel and E-85 exists.

V. COMPLIANCE WITH THE EPACT CRITERIA

Criterion One: ***'SUBSTANTIALLY NOT PETROLEUM'***

SUMMARY: The Pure fuel will be at least 60 percent and usually 100 percent non-petroleum.

The Pure fuel will be a blend of ethanol, pentanes plus (paraffins with five to eight carbon atoms), and a co-solvent, methyltetrahydrofuran (MTHF), in varying proportions according to the climate and whether a premium blend is desired. In severe cold weather, butane will be added to meet cold start requirements. Chemical properties of the fuel are specified in Appendix A-ii.

Both the ethanol and the MTHF will be derived from renewable resources – e.g., waste cellulosic biomass such as waste paper, agricultural waste, and urban/industrial wood waste – using existing processes, some patented by others, of hydrolysis and fermentation. The pentanes plus are expected to come exclusively from natural gas liquids; however, they can also be derived from coal gas or petroleum refining, and there may be some uncertainty as to the source of the supply if the pentanes plus are purchased from pipeline terminals or in the open market. Again, the fuel blends described below are intended to represent options within possible blending ranges – of pentanes plus, from 10 percent to 50 percent by volume; MTHF, from 15 percent to 55 percent; ethanol, from 25 percent to 55 percent; and butane, from zero to 15 percent. The company proposes to vary the components of its fuels to meet particular market demands. Thus, the fuel is expected to be entirely non-petroleum; in the worst case, its non-petroleum fraction (and the renewable fraction) will be as follows, based on the BTU content of each fuel. (See also Appendix A-i.)

(percentage by net heating value)

	BTU	Reg.	Prem.	Cold
Pentanes plus	112,600	36.2%	33.3%	19.1%
MTHF	110,000	37.7%	22.1%	32.3%
Ethanol	77,000	26.1%	44.6%	37.5%
N-butane	98,000			11.2%
BTU content		99,295	92,565	93,586
% Renewable non-petroleum (excluding natural gas liquids, butane)		63.8%	66.7%	69.8%

To reiterate, the last numbers are extreme worst-case estimates. Because the pentanes plus are expected to be derived from natural gas liquids, the Pure fuel is expected to be 100 percent non-petroleum. It is almost inconceivable that the average renewable, non-petroleum content of the Pure fuel would ever go as low as these numbers on an annual basis.

Criterion Two: 'SUBSTANTIAL ENERGY SECURITY BENEFITS'

SUMMARY: The Pure fuel can displace gasoline – and thus our reliance on imported oil – on nearly a gallon-for-gallon basis. Domestic supplies of biomass feedstocks are ample, initially from waste biomass and ultimately from energy crops.

The Pure fuel, as previously noted, will be 100 percent domestic. It can displace gasoline on nearly a gallon-for-gallon basis: The lower energy content of the Pure fuel displaces 0.88 gallons of reformulated gasoline in vehicle use, but the fossil energy used to produce the Pure fuel is less than that required to produce RFG; the energy savings equates to approximately 13,800 BTU or 0.12 gallons of RFG equivalent. Therefore, use of one gallon of the Pure fuel would in fact displace about one gallon of RFG, or roughly 113,000 BTU of imported oil. The fuel's contribution to the nation's energy security will be limited only by the amount it is used and the availability of the biomass feedstocks – and in the long run that will be limited only by the availability of land and the remarkable productivity of the American farmer.

In the near term, the limiting factor is more likely to be the availability of vehicles capable of operating on the Pure fuel, not the amount of fuel produced. The Department of Energy has projected 3 million alternative fuel vehicles on the market by 2005; if half of those are FFVs and all use the Pure fuel, they would require 1.5 billion gallons of fuel.¹⁵

Large supplies of waste biomass – such as rice straw and corn fiber, sawdust and pulp and paper sludge, the lignocellulosic fraction of the solid waste stream, even yard trimmings from residential trash – are readily available to meet the feedstock requirements of both the Pure fuel and ethanol markets.

An analysis of currently recoverable biomass in consolidated form – i.e., the currently collected portions of the biomass, not what is actually produced and available – shows a total of 92.7 million dry tons per year of agricultural residues, waste woods, corrugated cardboard, and waste paper.¹⁶ At a nominal 100 gallons of ethanol/MTHF per ton, that would translate into 9.3 billion gallons of ethanol/MTHF or roughly 13.9 billion gallons of the Pure fuel. Similarly, SWAN Biomass Company has estimated that as much as 13 billion gallons a year of cellulosic ethanol could be produced from readily available waste materials alone. This compares with current ethanol production (from corn and other starch sources) of up to 1.6 billion gallons a year and total U.S. gasoline consumption of 120 billion gallons a year.

If a larger market for biomass-derived fuels develops, farmers will respond by producing low-cost energy crops, such as switchgrass and other native American prairie grasses, especially for this purpose on underutilized U.S. farmland. This includes land now set aside under the Conservation Reserve Program. Based on estimates of land availability for alternative crops, biomass could sustainably produce as much as 20 percent of America's total energy needs early in the next century – or more than the total U.S. gasoline demand of about 120 billion gallons per year.

¹⁵ Assumes average use of 1000 gallons per year.

¹⁶ U.S. Department of Energy, *Alternative Feedstocks Program Technical and Economic Assessment*, Bozell, J.J., and Landucci, R. (editors), July 1993.

Putting this once more into context, U.S. dependence on imported oil is again on the rise and will reach 50 percent by the year 2000. As a result, the world's economic security rests uneasily on the stability of the House of Fahd – a feudal monarchy in a desert kingdom in one of the most volatile regions of the world. We need an alternative – alternative fuels – to avoid the need to shed American blood to protect our access to oil. In economic terms alone, the military cost of protecting the Persian Gulf oil fields has been estimated at approximately \$50 billion a year.¹⁷ Cellulosic ethanol is one of the few alternatives on the horizon that promises to be economically competitive with gasoline, while working within our existing transportation fuel system, requiring few changes to vehicles or supply infrastructure.

The Pure production process results in a highly positive energy balance. While the calculations will vary according to the specific blend, a typical gallon of the fuel will require 76,794 BTU of energy to produce but will contain 98,612 BTU and will result in byproducts (formic acid, silica, and lignin) with an additional energy value of 59,348 BTU, for a net gain of 81,166 BTU. In other words, for every unit of energy that goes into the production process, more than two units will result. The lignin is expected to serve as the fuel for the production process, avoiding the need for purchased power produced from fossil fuels. (See also Appendix B for additional data and a schematic diagram of the energy flows.)

Furthermore, the Pure fuel has the potential to extend the supply (and thus the scope of energy security benefits) of cellulosic ethanol by roughly 50 percent, as the pentanes plus fraction of the fuel (also domestic in origin) blends with the portion derived from biomass and backs out more oil.

Finally, as noted above, the fuel can also be expected to spur sales of flexible-fuel vehicles, providing the nation with greater flexibility in responding to energy security threats, whether in the form of fuel pricing pressures or threatened or actual curtailments in foreign imports.

Criterion Three: *'SUBSTANTIAL ENVIRONMENTAL BENEFITS'*

SUMMARY: The Pure fuel has favorable emission characteristics relative to both conventional and reformulated gasoline, as well as E-85. In addition, it reduces greenhouse gas emissions by nearly two-thirds compared to gasoline.

The Pure fuel requires no refining and contains essentially no undesirable olefins, sulfur, or aromatics, such as benzene. As a result, it has very clean emissions characteristics. Tests of the fuel were recently performed by Automotive Testing Laboratories near Columbus, Ohio, on two standard, unmodified 1997 Ford Taurus E-85 FFVs, using fuel blended from commercially available components that were purchased for that purpose. At the time of testing, these were the only available production E-85 FFVs.

¹⁷ Jenny B. Wahl, Ph.D., "Oil Slickers: How Petroleum Benefits at the Taxpayer's Expense," Institute for Local Self-Reliance, August 1996, reviewing a range of external estimates.

The Pure fuel's emissions were compared in the two conventional blends described above – regular and premium – to an indolene equivalent (UTG-96), Phase II ("California") reformulated gasoline (RFG), commercial "street" gasoline, and E-85, using both the current federal testing procedure and the USO6 test, which involves acceleration and high-speed driving patterns that are more reflective of typical driving. The results are presented in detail in Appendix C-i but will be summarized here.

One conclusion stands out – on balance and on both tests, the Pure fuel resulted in the lowest overall exhaust emissions of any of the five test fuels. Evaporative emissions were somewhat higher than the other fuels but were comparable. The Pure fuel easily met the federal Tier 1 standards in every case.

With regard to both non-methane hydrocarbons and total hydrocarbons, both Pure blends were the best performers on the FTP test – reducing emissions by almost a third compared to RFG. On the USO6 test, E-85 performed slightly better, but the Pure fuel's margin over RFG increased.

Similar results were obtained for ozone-forming potential (where the Pure blends had half the emissions of RFG on the USO6 test), for carbon monoxide (nearly that same level of reduction), and for air toxics (a reduction of roughly two-thirds).

With regard to NO_x emissions, the results were widely scattered. On average, both indolene and RFG outperformed the Pure blends but by a small margin. On the FTP test, RFG did best, and the other five fuels were very similar. On the USO6 test, indolene did best, RFG and Pure regular were similar, and E-85 and Pure premium were similar.

Clearly, widespread use of the Pure fuel would result in substantial air quality benefits compared to existing alternatives. The emissions resulting from production of the fuel are also lower than those associated with the production of reformulated gasoline -- 71 percent less on a gallon-for-gallon comparison. Most dramatically, methane emissions are reduced by more than 99 percent relative to RFG production. (See also Appendix C-ii.)¹⁸

The Pure fuel's environmental benefits are particularly dramatic with regard to greenhouse gas emissions. Both blends performed better than either RFG or indolene in terms of direct carbon dioxide emissions, but more importantly, the Pure blends result in major reductions in carbon dioxide emissions when considered on a life-cycle basis. The fuel's composition means that it will be approximately 60 percent derived from biomass. Because biomass needs carbon dioxide to grow, the production of biomass for energy absorbs the very greenhouse gases that are given off when it is used. In other words, its net contribution to global warming is zero. This is called a closed carbon cycle. Assuming sustainable production practices, the biomass content of the Pure fuel means that for every gallon of gasoline replaced, roughly 60 percent of the carbon emissions associated with that gallon will also be avoided. Specifically, Pure regular is estimated to reduce carbon dioxide use by 63 percent relative to RFG and Pure premium by 66 percent based on total life cycle of feedstock and production processes of the Pure fuel components. (See Appendix B for a schematic diagram of the carbon flows.)

¹⁸ Wang, M., GREET 1.3 fuel cycle model, Argonne National Laboratory, May 1997.

If the nation is going to honor its commitment to reduce greenhouse gas emissions to forestall the danger of global climate change, biomass energy is one of our most important options. Thus, if biomass supplied 20 percent of the nation's energy needs, replacing fossil fuels, it would reduce greenhouse gas emissions from those sources by a like amount. Very few other technologies have the potential to make such a large contribution in the near term.

The so-called "Car Talk" committee, formally known as the Policy Dialogue Advisory Committee to Develop Options for Reducing Greenhouse Gas Emissions from Personal Motor Vehicles, was unable to agree on a unified strategy to recommend to the President because of disagreements over the appropriate role of fuel economy standards. But on one point the committee was united – the importance of liquid biofuels.

The Majority Report of the Car Talk committee found "a substantial consensus within the technical community regarding the strong potential of cellulosic biomass-based fuel options for greenhouse gas mitigation" and recommended a \$100 million annual R&D budget for this topic alone. The dissenting report of the auto industry members similarly concluded that with "significant support for research," cellulosic biomass fuels could produce a "technological home run" on greenhouse gas reductions.

Perennial biomass energy crops (such as switchgrass, willows, or hybrid poplars) have other environmental benefits as well. They stabilize the soil and reduce the runoff of pesticides and other chemicals from adjacent lands into our waterways. For this reason, they could be grown and harvested on fragile and erodible land, producing income to the farmer while storing carbon and protecting the soil. They can also provide good wildlife habitat.

Since the Pure fuel will be produced domestically, it will not need to rely on shipment by tanker. To the extent that it reduces oil imports, it will also reduce the overseas transportation of oil and the attendant risk of oil spills.

To the extent that waste feedstocks are used, particularly if drawn from the solid waste stream, the Pure fuel process will be recycling materials that would otherwise be a disposal burden.

Finally, it is worth noting that, based on preliminary evaluations, the Pure fuel appears to be less hazardous to human health than conventional gasoline. It has been tested for potential human toxicity in a number of recently conducted animal studies. Based on the results of the animal testing, the fuel is considered to have lower inhalation toxicity than gasoline. The Pure fuel is not a skin sensitizer and has been shown to be non-mutagenic/genotoxic in bacterial assays.

VI. ECONOMIC IMPACTS

EPACT's legislative history indicates that achieving the domestic economic development benefits inherent in greater reliance on domestically produced, agriculturally derived sources of energy was a goal of the legislation as well. As the situation now stands, our annual \$50 billion in oil imports has significant adverse economic consequences for the nation: It contributes to inflation. It depletes our domestic investment capital. It devalues our currency and reduces our standard of living.

What if we spent those billions of dollars every year in the Middle West instead of the Middle East? Because biomass is bulky, it doesn't pay to ship it very far. Biofuels facilities typically will rely on feedstocks produced within a 50-mile radius. That means investment, construction, new jobs, and economic growth throughout rural America. The Department of Agriculture has estimated that 27,000 new jobs are created for every 1 billion gallons of ethanol produced from corn; similar numbers would pertain, at a potentially much larger scale, to ethanol produced from biomass.

The existing ethanol industry in this country, which has a production capacity of about 1.6 billion gallons a year, was recently estimated by economist Michael K. Evans to increase net farm income by more than \$4.5 billion annually, boosting employment by 192,000 jobs and resulting in net federal budget savings of more than \$3.5 billion. Yet the potential impact of using the entire scope of our biomass resources to produce transportation fuels is vastly larger. Based on estimates of land availability for alternative crops, biomass could sustainably produce as much as 20 percent of America's total energy needs early in the next century – or more than the total U.S. gasoline demand of about 120 billion gallons per year.

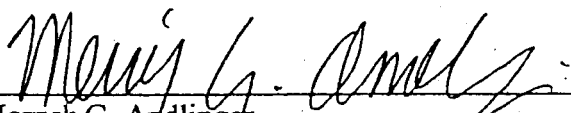
In order to develop the U.S. biomass energy industry, the critical need today is for demonstrations of the conversion technology and energy crops that have been developed with federal support over the last 20 years. The company's access to the capital needed for these projects will be enhanced by an early determination by the Department that the Pure fuel does in fact qualify as an alternative fuel under EPACT.

Small federal actions now can reduce the risk to the private sector and make big projects happen. Designation of the Pure fuel as an alternative fuel under EPACT is one such step, and prompt action by the Department on this issue is therefore in the national interest.

VI. CONCLUSION

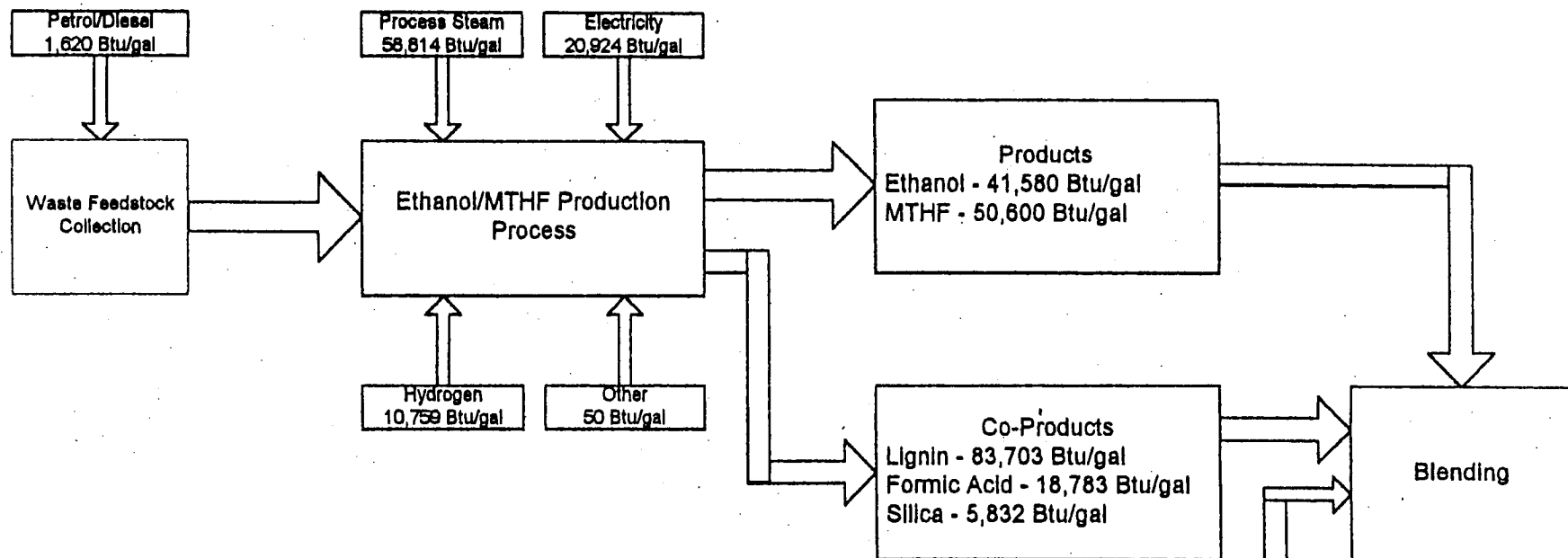
Insofar as the Pure fuel meets the tests set forth in the Energy Policy Act - that is, it is "substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits," by this petition Pure Energy Corporation respectfully requests the Secretary of Energy to take prompt action to initiate a rulemaking determining that the Pure fuel qualifies as an alternative fuel under Section 301(2) of EPACT.

Submitted the 30th day of June, 1997.

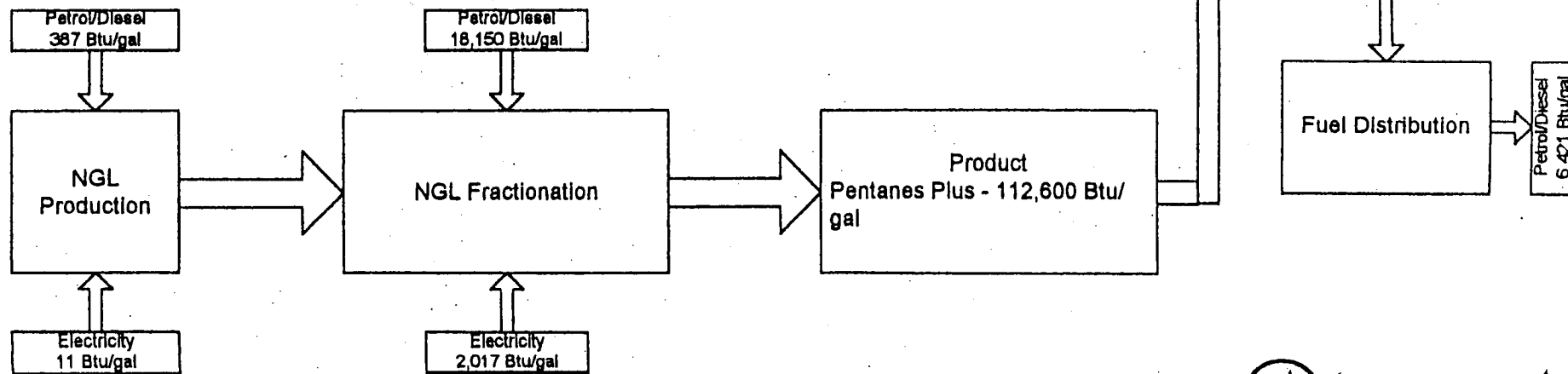


Merrick G. Ardinger
President and Chief Executive Officer
Pure Energy Corporation

Ethanol/MTHF Integrated Production Process



NGL to Pentanes Plus Production Process



A i. Fuel Composition by Energy Content

Regular	Btu/gal	% by volume	Btu	% by Btu
Components				
Ethanol	77,000	35.0%	26,950	27.1%
MTHF	110,000	32.5%	35,750	36.0%
Pentanes Plus	112,600	32.5%	36,595	36.9%
n-Butane	98,000	-	-	-
Total		100.0%	99,295	100.0%

Premium	Btu/gal	% by volume	Btu	% by Btu
Components				
Ethanol	77,000	55.0%	42,350	45.8%
MTHF	110,000	17.5%	19,250	20.8%
Pentanes Plus	112,600	27.5%	30,965	33.5%
n-Butane	98,000	-	-	-
Total		100.0%	92,565	100.0%

Cold Weather	Btu/gal	% by volume	Btu	% by Btu
Components				
Ethanol	77,000	47.0%	36,190	38.7%
MTHF	110,000	26.0%	28,600	30.6%
Pentanes Plus	112,600	16.0%	18,016	19.3%
n-Butane	98,000	11.0%	10,780	11.5%
Total		100.0%	93,586	100.0%

A ii. Fuel Properties

	Pure Blends****					
	UTG-96*	RFG II**	E-85***	Regular	Premium	Cold Weather
Specific Gravity	0.7444	0.738	0.783	0.775	0.743	0.773
Initial Boiling Point (F)	93	101	120	108.7	103.5	83.7
R+M/2	91.9	91.7	96	90.2	93.8	93.3
Net Energy Content (Btu/gal)	114,500	111,800	83,500	99,295	92,565	93,586
Sulfur (ppm)	100	33	8	< 9	< 9	< 9
RVP (psi)	9.2	6.9	6.9	7.8	8.0	14.0
Benzene (vol%)	0.78	1.28	0.32	0.27	0.22	0.04
Oxygen (wt%)	0	2.0	34.0	19.5	20.0	16.8

* Unleaded reference fuel (Phillips brand)

** California Reformulated Gasoline (RFG) Phase II

*** 85% Ethanol/15% Gasoline

**** Representative blends

B i. Energy Life Cycle

Energy Input

<u>Integrated Ethanol/MTHF process</u>				
	Feedstock Production Btu/gal	Fuel Production Btu/gal	Fuel Distribution Btu/gal	Subtotal
1) Petroleum/Diesel	1,620	-	8,475	10,095
2) Process Steam	-	58,814	-	58,814
3) Electricity	-	20,924	-	20,924
4) Hydrogen	-	10,759	-	10,759
5) Other		50		50
Subtotals	1,620	90,547	8,475	
Energy input to produce 1 gallon from integrated process				100,642
Integrated process contribution to produce one gallon of Pure Fuel				68,940

<u>NGLs to Pentanes Plus process</u>				
1) Petroleum/Diesel	387	18,150	1,596	20,133
2) Electricity	11	2,017	359	2,387
Subtotals	398	20,167	1,955	
Energy input to produce 1 gallon from NGL process				22,520
NGL process contribution to produce one gallon of Pure Fuel				7,094

Total Energy required to produce one gallon of Pure Fuel **76,034**

Energy Value of Products & Co-Products

<u>Integrated Ethanol/MTHF process</u>		Subtotal Btu/gal
1) Ethanol		41,580
2) MTHF		50,600
3) Formic Acid		18,783
4) Silica		5,832
5) Lignin		83,703
Subtotals		
Energy output from producing 1 gallon from integrated process		200,498
Integrated process contribution from producing one gallon of Pure Fuel		137,341

<u>NGLs to Pentanes Plus process</u>		
1) Pentanes Plus		112,600
Subtotals		
Energy output from producing 1 gallon from NGL process		112,600
NGL process contribution from producing one gallon of Pure Fuel		35,469

Total Energy output from producing one gallon of Pure Fuel **172,810**

Net Energy Gain **96,777**

Process Efficiency **227%**

FTP

EVAPORATIVE

Test #	Car	Fuel	Methane	NMHC	THC	NMHC	THC	Spec. React.	CO	NOx	CO2	MPG	Miles per MMBtu	Ttl Toxics	PWT	Diurnal	Hot Soak
Tests conducted from July to September, 1998 *																	
5544	5446	P-mid	0.054	0.093	0.147	0.109	0.329	3.025	1.310	0.120	424.42	16.69	171.88	5.40	0.70	0.058	0.060
5550	5446	P-mid	0.047	0.085	0.131	0.098	0.299	3.059	1.236	0.114	427.01	16.60	170.96	5.14	0.66	0.062	0.083
5568	5446	UTG-96	0.031	0.142**	0.173**				1.520	0.080	436.88	20.15	175.94				
5574	5446	UTG-96	0.032	0.129**	0.161**				1.309	0.075	438.13	20.11	175.59				
5547	5539	P-mid	0.059	0.087	0.145	0.096	0.301	3.139	1.375	0.199	416.22	17.02	175.28	5.43	0.58	0.024	0.068
5551	5539	P-mid	0.059	0.098	0.156	0.114	0.334	2.931	1.307	0.200	415.80	17.04	175.49	5.34	0.64	0.056	0.090
5563	5539	UTG-96	0.027	0.16**	0.187**				1.299	0.120	439.27	20.06	175.15				
5569	5539	UTG-96	0.029	0.112**	0.141**				1.513	0.092	437.22	20.14	175.85				
Tests conducted from February to June, 1997 (as previously submitted in Pure Energy's original petition dated June 30, 1997) *																	
7391	5446	P-reg	0.022	0.064	0.085	0.087	0.294	3.398	1.032	0.098	406.35	17.65	176.50	6.05	0.65	0.069	0.145
7314	5446	P-reg	0.020	0.063	0.085	0.081	0.282	3.473	1.063	0.049	406.20	17.64	176.40	5.48	0.63	0.049	0.119
7432	5446	P-reg	0.018	0.076	0.093	0.095	0.321	3.369	1.090	0.074	405.23	17.68	176.80	6.50	0.65	0.063	0.134
7302	5446	UTG-96	0.034	0.121	0.154	0.133	0.431	3.244	0.151	0.165	423.94	20.94	182.83	9.60	2.10	0.039	0.097
7305	5446	UTG-96	0.028	0.110	0.139	0.117	0.388	3.314	0.136	0.143	423.51	20.96	183.01	9.56	1.97	0.040	0.089
7321	5539	P-reg	0.032	0.077	0.112	0.091	0.304	3.347	1.072	0.060	409.70	17.48	174.80	6.68	0.92	0.060	0.126
7330	5539	P-reg	0.028	0.081	0.109	0.099	0.322	3.266	1.130	0.047	409.44	17.49	174.90	6.28	0.70	0.053	0.123
7478	5539	UTG-96	0.033	0.196	0.227	0.209	0.644	3.088	0.224	0.239	421.82	21.00	183.36	13.17	2.74	0.024	0.075
7482	5539	UTG-96	0.027	0.142	0.168	0.146	0.490	3.345	0.165	0.170	420.10	21.12	184.41	11.07	2.34	0.062	0.096

* Tested conducted at Automotive Testing Laboratories on 1997 Ford Taurus E85 FFVs

** Emissions are NMHC and THC, not NMHC and THCE.



TP

Test #	Car	Fuel	Methane	NMHCE	THCE	NMOG	OPF	Spec. React.	Corr. HC	Til. HC	CO	NOx	CO2	MPG
7302	5446	UTG-98	0.034	0.121	0.154	0.133	0.431	3.244	0.151	0.185	1.283	0.07	423.94	20.94
7305	5446	UTG-96	0.028	0.11	0.139	0.117	0.388	3.314	0.136	0.143	1.268	0.05	423.51	20.96
7391	5446	PUR1	0.022	0.084	0.085	0.087	0.294	3.399	0	0	1.032	0.096	406.35	17.85
7314	5446	PUR1	0.02	0.083	0.085	0.081	0.282	3.473	0	0	1.083	0.048	406.2	17.84
7432	5446	PUR1	0.018	0.076	0.093	0.095	0.321	3.369	0	0	1.09	0.074	405.23	17.66
7316	5446	E85	0.037	0.135	0.172	0.238	0.552	2.328	0	0	1.33	0.075	396.11	15.39
7323	5446	E85	0.038	0.116	0.152	0.18	0.475	2.633	0	0	1.235	0.07	401.45	15.2
7335	5446	RFG II	0.034	0.119	0.147	0.134	0.503	3.744	0.144	0.165	1.302	0.044	421.27	20.59
7363	5446	RFG II	0.021	0.089	0.108	0.1	0.387	3.855	0.106	0.119	1.068	0.033	420.19	20.87
7553	5446	PUR2	0.023	0.048	0.070	0.101	0.290	2.864			0.958	0.056	395.440	16.62
7556	5446	PUR2	0.025	0.068	0.090	0.100	0.282	2.826			0.994	0.047	396.420	16.57
7604	5446	COMS	0.035	0.126	0.158	0.137	0.487	3.559	0.158	0.188	1.514	0.108	424.790	20.72
7612	5446	COMS	0.038	0.128	0.164	0.138	0.442	3.212	0.161	0.175	1.422	0.090	421.980	20.86
7321	5539	PUR1	0.032	0.077	0.112	0.091	0.304	3.347	0	0	1.072	0.06	409.7	17.48
7330	5539	PUR1	0.028	0.081	0.109	0.099	0.322	3.268	0	0	1.13	0.047	409.44	17.49
7390	5539	RFG II	0.028	0.113	0.137	0.127	0.446	3.535	0.134	0.152	1.219	0.039	412.73	21.03
7393	5539	RFG II	0.033	0.137	0.165	0.168	0.539	3.422	0.165	0.188	1.4	0.038	414.44	20.92
7434	5539	E85	0.049	0.114	0.161	0.203	0.488	2.404	0	0	1.114	0.031	396.49	15.39
7449	5539	E85	0.05	0.117	0.165	0.203	0.482	2.273	0	0	1.192	0.047	395.07	15.44
7478	5539	UTG-98	0.033	0.188	0.227	0.209	0.644	3.088	0.224	0.239	1.731	0.058	421.82	21.00
7482	5539	UTG-96	0.027	0.142	0.168	0.148	0.49	3.345	0.195	0.17	1.422	0.049	420.1	21.12
7557	5539	PUR2	0.038	0.072	0.107	0.096	0.287	2.934			1.09	0.074	398	16.50
7563	5539	PUR2	0.031	0.068	0.098	0.098	0.272	2.771			1.208	0.053	399.56	16.43
7603	5539	COMS	0.039	0.172	0.209	0.182	0.600	3.308	0.205	0.218	1.457	0.108	424.1	20.75
7617	5539	COMS	0.039	0.157	0.194	0.172	0.559	3.258	0.191	0.215	1.315	0.074	418.48	21.04

JSO6

Test #	Car	Fuel	Methane	NMHCE	THCE	NMOG	OPF	Spec. React.	Corr. HC	Til. HC	CO	NOx	CO2	MPG
7302	5446	UTG-98	0.042	0.190	0.231	0.208	0.570	2.735	0.227	0.249	12.658	0.053	371.424	22.78
7305	5446	UTG-96	0.041	0.144	0.180	0.153	0.411	2.691	0.177	0.192	10.947	0.039	378.820	22.52
7391	5446	PUR1	0.038	0.039	0.075	0.048	0.172	3.611	0.000	0.000	7.688	0.057	359.272	19.37
7314	5446	PUR1	0.029	0.034	0.063	0.039	0.135	3.426	0.000	0.000	5.427	0.078	364.100	19.31
7432	5446	PUR1	0.031	0.029	0.059	0.035	0.116	3.321	0.000	0.000	5.073	0.064	363.766	19.36
7316	5446	E85	0.046	0.024	0.063	0.025	0.098	3.948	0.000	0.000	5.414	0.096	361.750	16.57
7323	5446	E85	0.040	0.018	0.054	0.022	0.080	3.579	0.000	0.000	4.520	0.087	360.137	16.70
7335	5446	RFG II	0.042	0.118	0.153	0.133	0.408	3.062	0.151	0.175	11.452	0.073	376.049	22.12
7363	5446	RFG II	0.040	0.123	0.159	0.137	0.402	2.938	0.158	0.178	11.480	0.068	377.871	22.02
7351	5446	RFG II	0.038	0.121	0.157	0.132	0.398	3.009	0.000	0.000	11.154	0.038	379.505	21.85
7553	5446	PUR2	0.042	0.045	0.085	0.047	0.165	3.531			6.809	0.067	360.496	17.77
7556	5446	PUR2	0.032	0.026	0.057	0.029	0.098	3.340			5.241	0.088	364.572	17.70
7604	5446	COMS	0.049	0.181	0.227	0.172	0.500	2.905	0.223	0.215	14.584	0.089	379.184	22.00
7612	5446	COMS	0.042	0.187	0.207	0.172	0.549	3.182	0.203	0.214	11.892	0.083	375.445	22.44
7321/7341	5539	PUR1	0.035	0.035	0.068	0.058	0.200	3.459	0.000	0.000	6.358	0.045	368.467	19.01
7330	5539	PUR1	0.040	0.042	0.077	0.052	0.181	3.484	0.000	0.000	6.224	0.042	369.224	18.98
7390	5539	RFG II	0.034	0.094	0.122	0.102	0.322	3.170	0.120	0.135	8.540	0.045	372.415	22.80
7393	5539	RFG II	0.038	0.105	0.138	0.118	0.387	3.115	0.135	0.153	10.203	0.025	368.828	22.59
7434	5539	E85	0.048	0.016	0.062	0.019	0.063	3.300	0.000	0.000	4.795	0.070	361.225	16.63
7449	5539	E85	0.047	0.028	0.072	0.029	0.108	3.705	0.000	0.000	5.877	0.063	355.923	16.80
7478	5539	UTG-98	0.034	0.150	0.182	0.160	0.485	3.038	0.179	0.194	12.936	0.046	385.650	21.96
7482	5539	UTG-96	0.036	0.131	0.168	0.141	0.412	2.922	0.163	0.176	11.408	0.023	378.232	22.51
7557	5539	PUR2	0.047	0.057	0.102	0.061	0.238	3.886			7.832	0.092	365.997	17.43
7563	5539	PUR2	0.033	0.033	0.065	0.037	0.131	3.516			5.053	0.077	360.474	17.91
7603	5539	COMS	0.038	0.136	0.172	0.137	0.413	3.014	0.188	0.172	8.948	0.062	386.421	22.01
7617	5539	COMS	0.040	0.162	0.200	0.171	0.543	3.179	0.196	0.211	11.794	0.072	377.411	22.34

TP

est #	Car	Fuel	Diurnal	Hot Soak	Ttl Toxics	PWT
7302	5446	UTG-96	0.039	0.097	9.6	2.1
7305	5446	UTG-96	0.04	0.089	9.8	2.0
7391	5446	PUR1	0.089	0.145	6.0	0.6
7314	5446	PUR1	0.049	0.139	5.5	0.6
7432	5446	PUR1	0.063	0.134	6.5	0.6
7316	5446	E85	0.046	0.104	20.8	0.8
7323	5446	E85	0.03	0.083	22.3	0.8
7335	5446	RFG II	0.044	0.11	8.5	2.1
7363	5446	RFG II	0.059	0.101	7.8	1.8
7553	5446	PUR2	0.048	0.133	7.9	0.6
7556	5446	PUR2	0.052	0.101	7.5	0.5
7604	5446	COMM	0.126	0.115	11.3	2.3
7612	5446	COMM	0.059	0.078	10.7	2.4

7321	5539	PUR1	0.06	0.128	6.7	0.9
7330	5539	PUR1	0.053	0.123	6.3	0.7
7390	5539	RFG II	0.052	0.105	6.9	2.1
7393	5539	RFG II	0.028	0.099	11.7	2.4
7434	5539	E85	0.046	0.099	20.0	0.8
7449	5539	E85	0.033	0.089	18.8	0.7
7478	5539	UTG-96	0.024	0.075	13.1	2.7
7482	5539	UTG-96	0.062	0.066	11.0	2.3
7557	5539	PUR2	0.041	0.088	7.5	0.8
7563	5539	PUR2	0.045	0.072	7.3	0.8
7603	5539	COMM	0.084	0.084	13.4	2.8
7617	5539	COMM	0.050	0.077	12.6	2.8

US06

Test #	Car	Fuel	Ttl Toxics	PWT
7302	5446	UTG-96	44.6	8.0
7305	5446	UTG-96	30.9	5.8
7391	5446	PUR1	4.6	1.2
7314	5446	PUR1	2.8	0.6
7432	5446	PUR1	2.5	0.6
7316	5446	E85	3.4	0.4
7323	5446	E85	2.8	0.4
7335	5446	RFG II	27.9	5.4
7363	5446	RFG II	28.3	5.4
7351	5446	RFG II	28.5	5.4
7553	5446	PUR2	5.3	1.2
7556	5446	PUR2	2.7	0.7
7604	5446	COMM	34.6	7.0
7612	5446	COMM	34.5	6.9

7321/7341	5539	PUR1	3.9	1.1
7330	5539	PUR1	4.0	1.3
7390	5539	RFG II	18.0	3.7
7393	5539	RFG II	22.3	4.4
7434	5539	E85	2.6	0.3
7449	5539	E85	4.0	0.7
7478	5539	UTG-96	29.7	5.8
7482	5539	UTG-96	26.9	5.2
7557	5539	PUR2	5.9	1.7
7563	5539	PUR2	2.2	0.9

Emissions Data Summary

Cold Test Results

Test #	Car	Fuel	CO
7595	5446	PUR3	8.03
7598	5446	PUR3	7.832
7626	5539	PUR3	8.345
7630	5539	PUR3	7.698
7589	5446	COMM	6.849
7592	5446	COMM	6.604
7564	5539	COMM	7.456
7597	5539	COMM	7.408

LEGEND

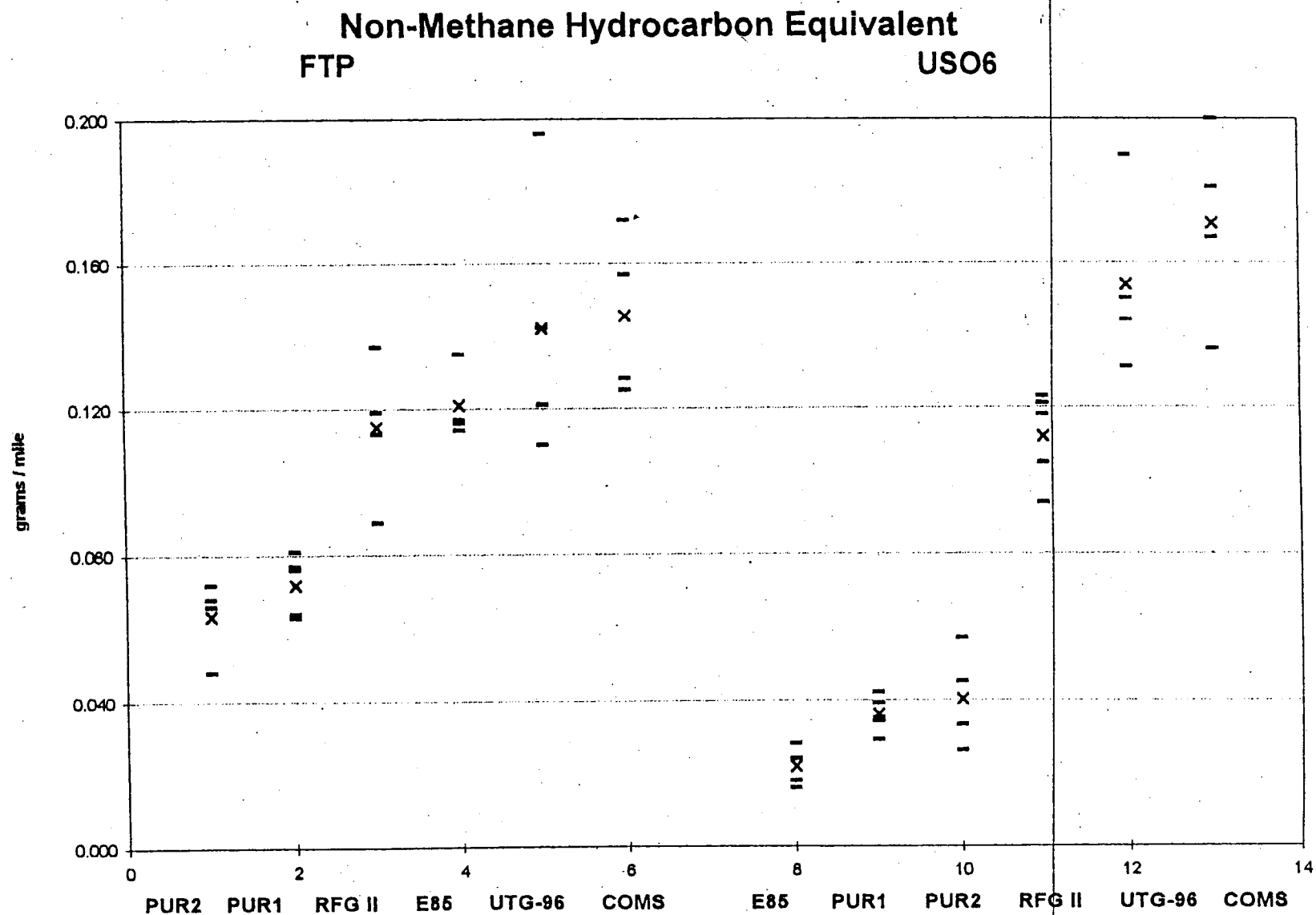
PUR1 = Pure Regular blend

PUR2 = Pure Premium blend

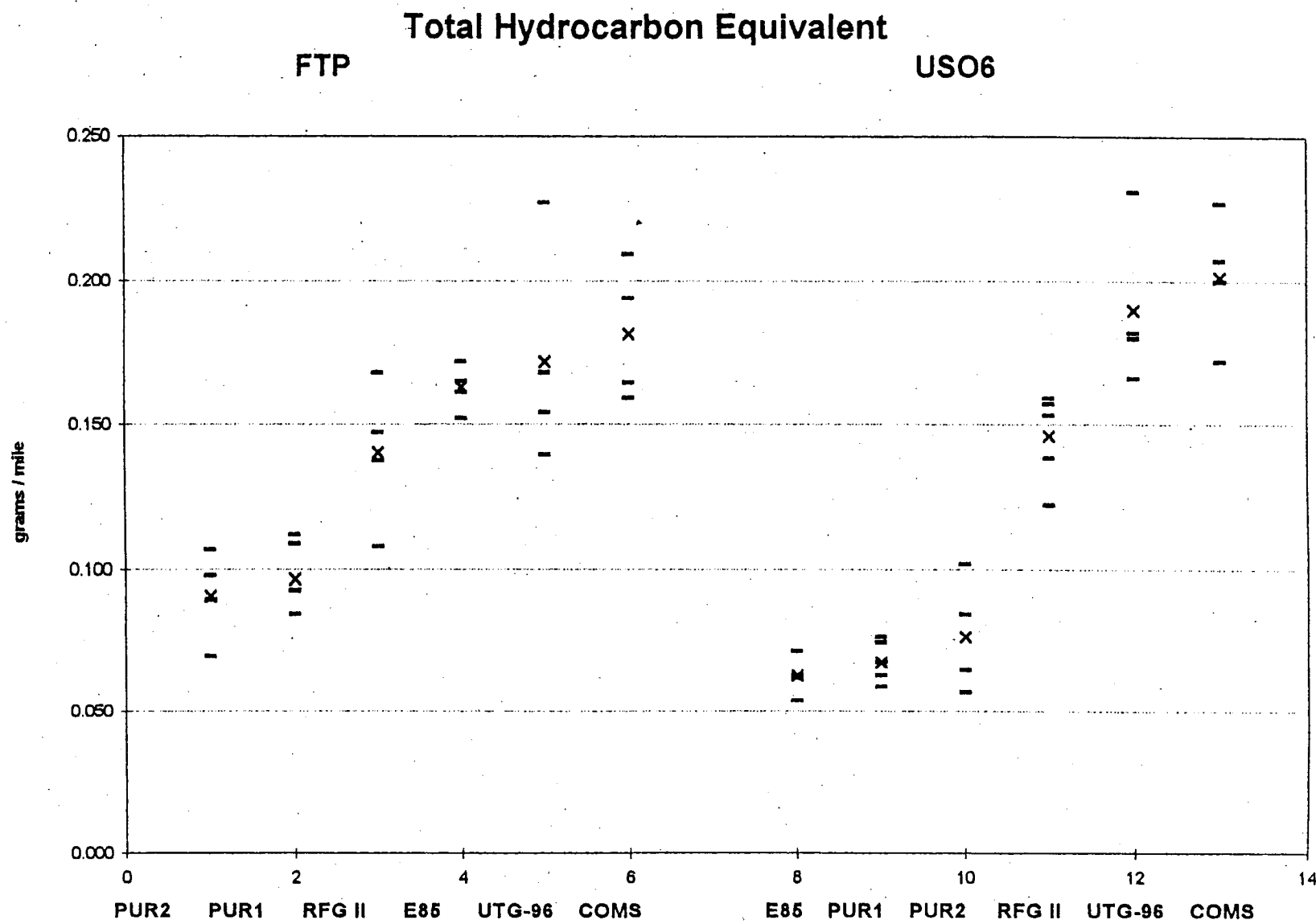
PUR3 = Pure Cold Weather blend

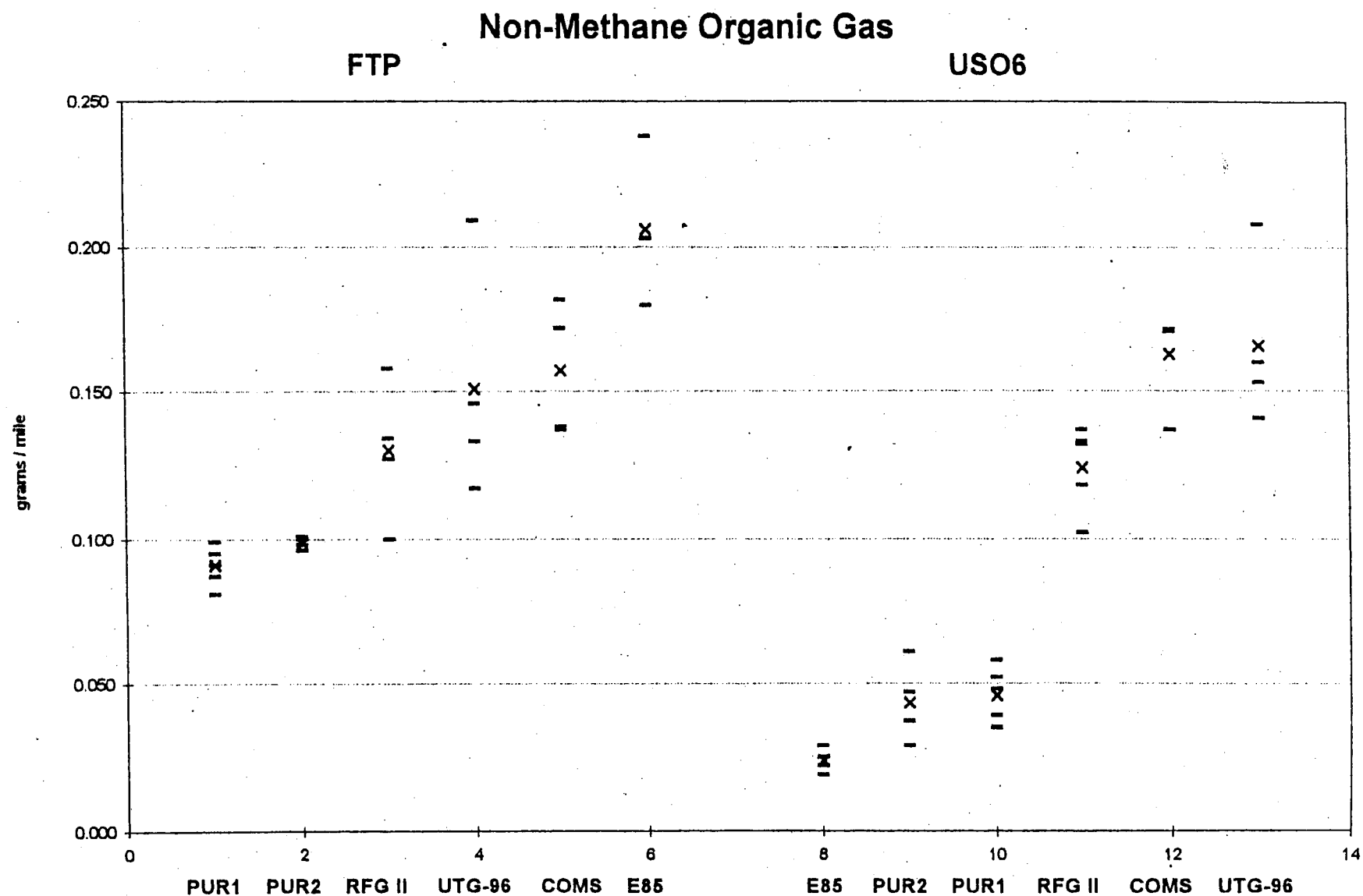
COMM = Commercial Street fuel

Street Winter fuel



Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends.
Tier I emissions standard for NMHC = 0.25 gram/mile.

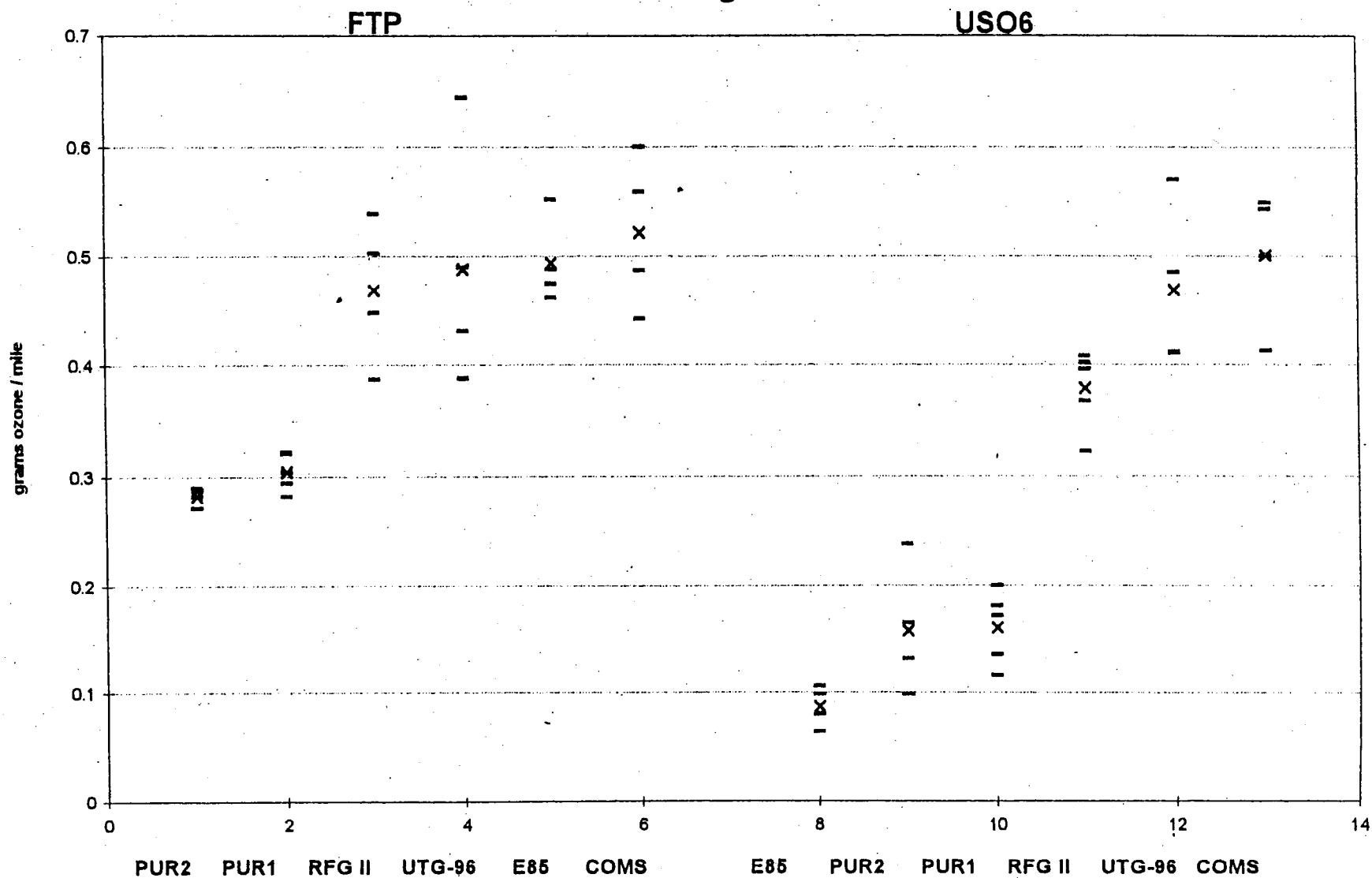




Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends



Ozone Forming Potential



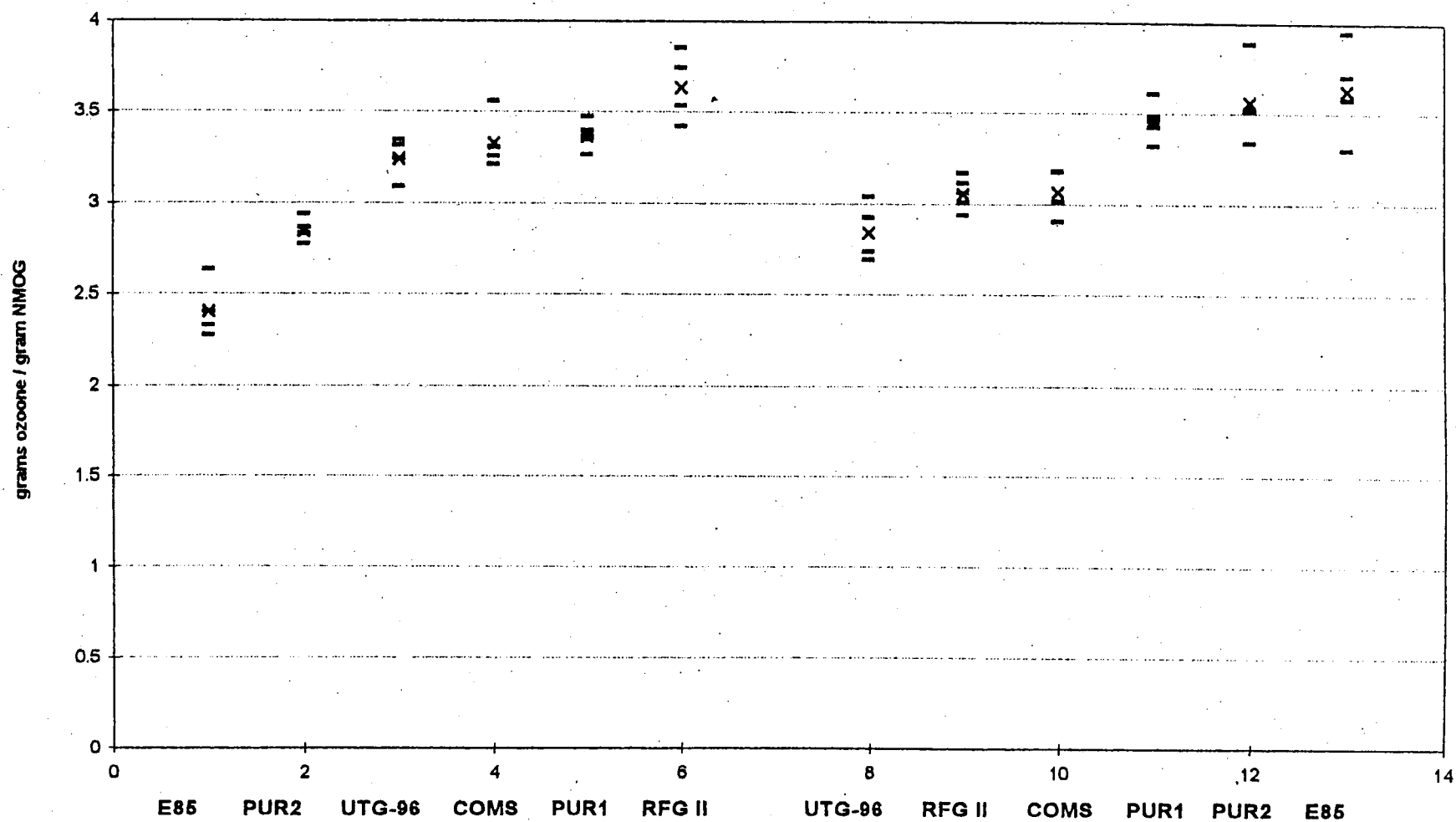
Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends

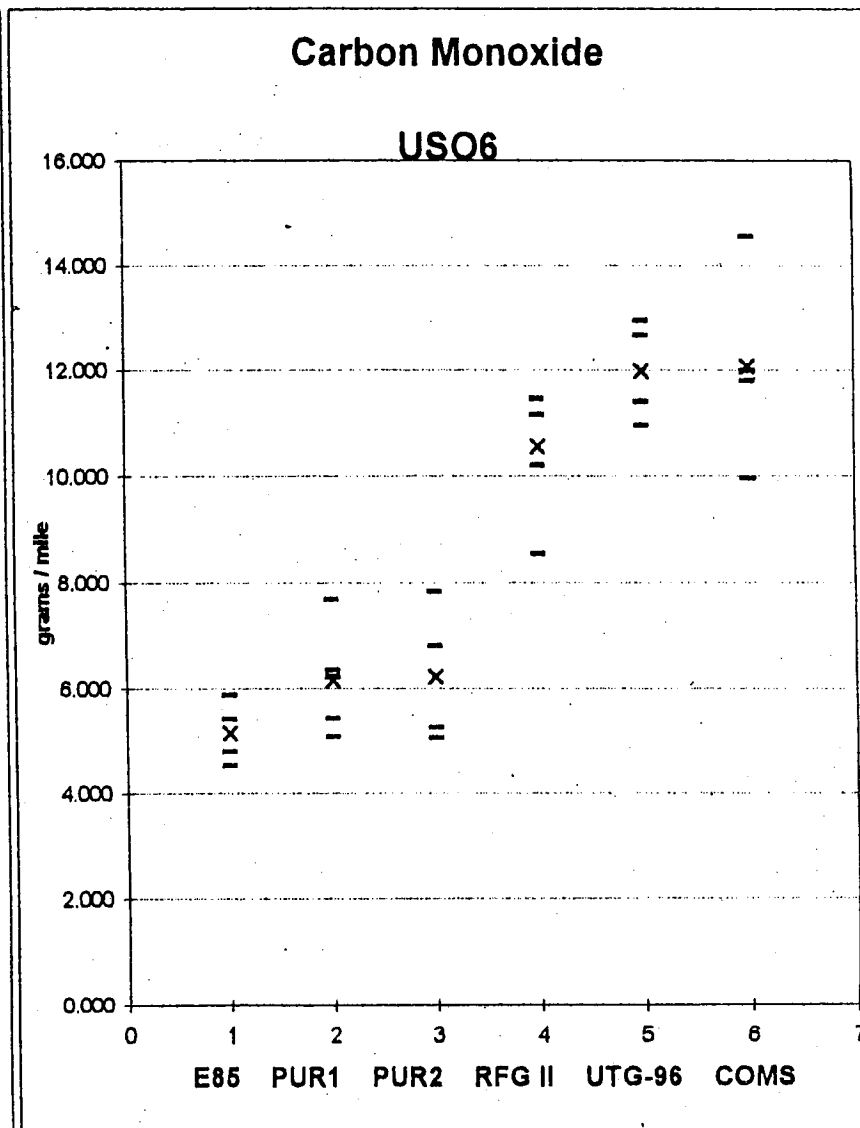
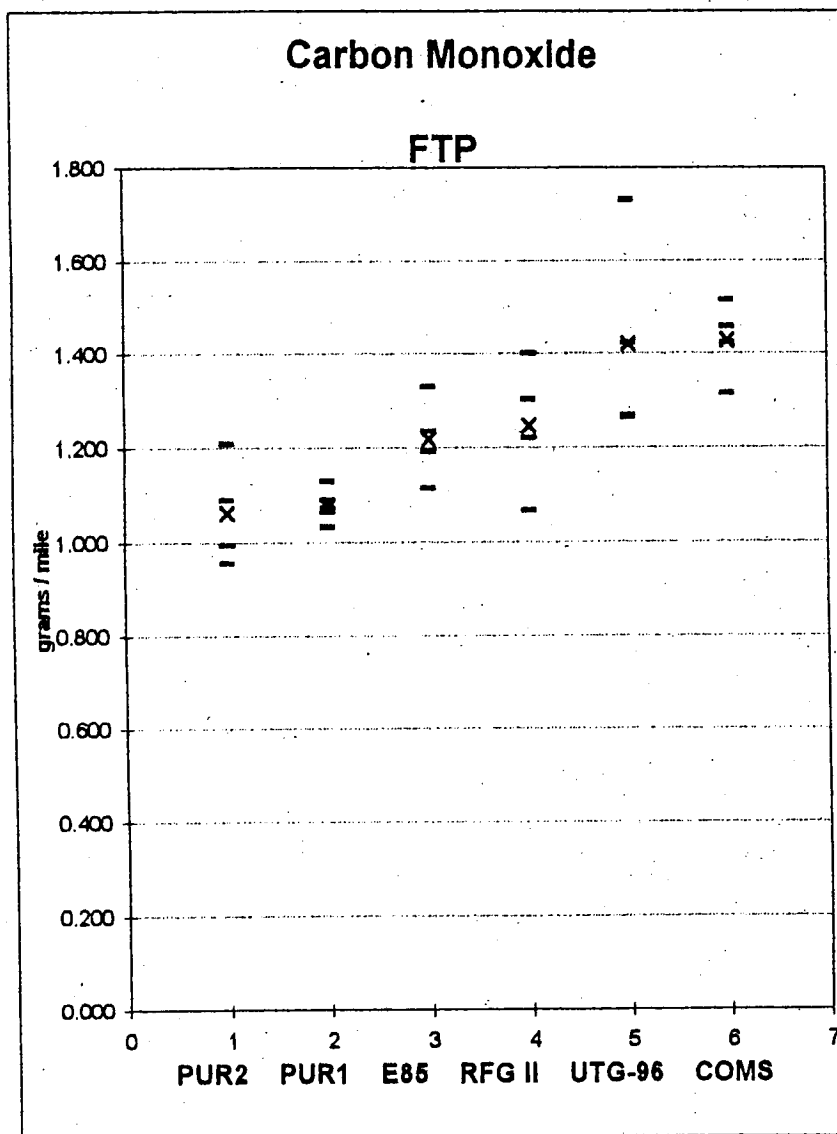


Specific Reactivity

FTP

USO6

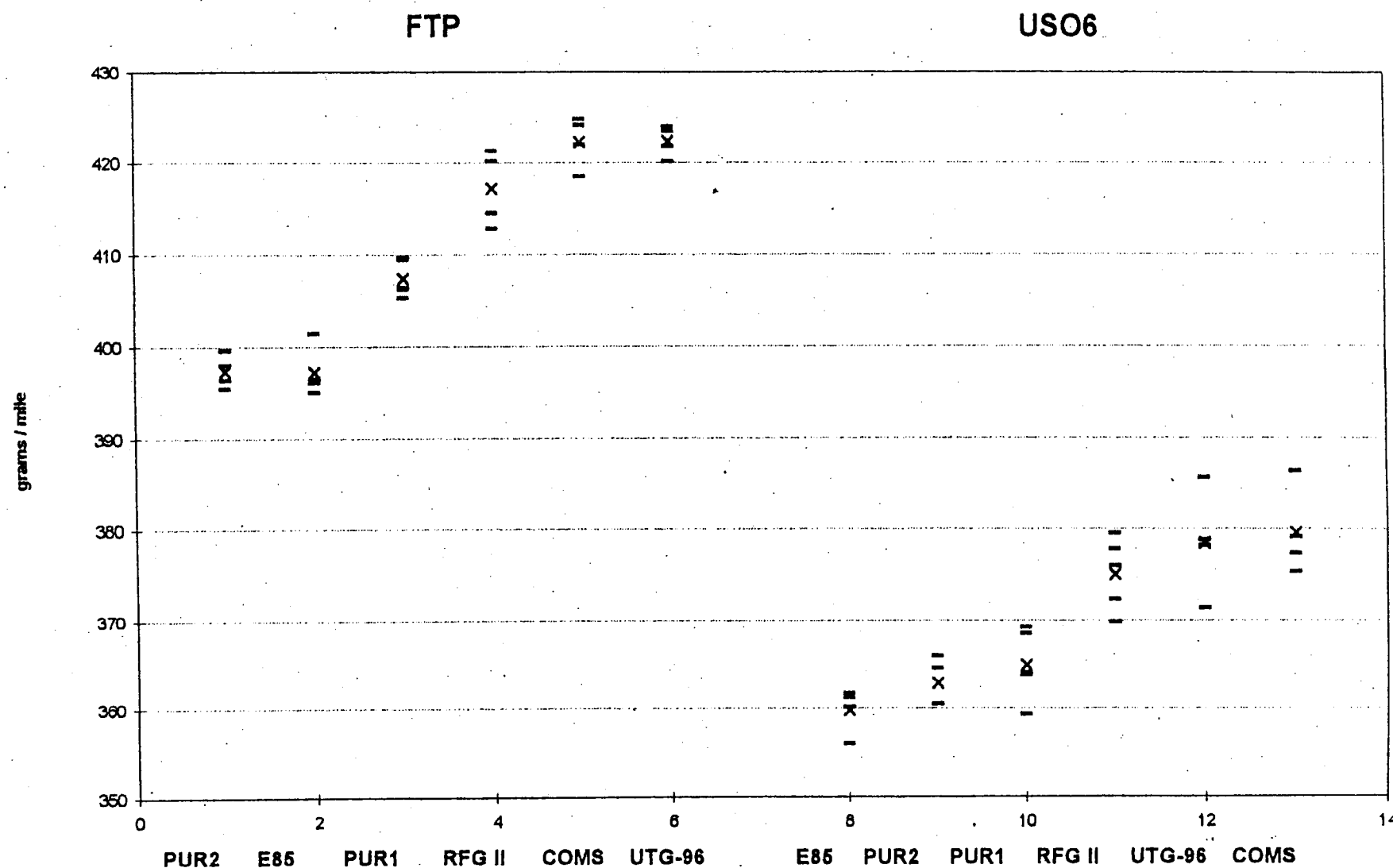




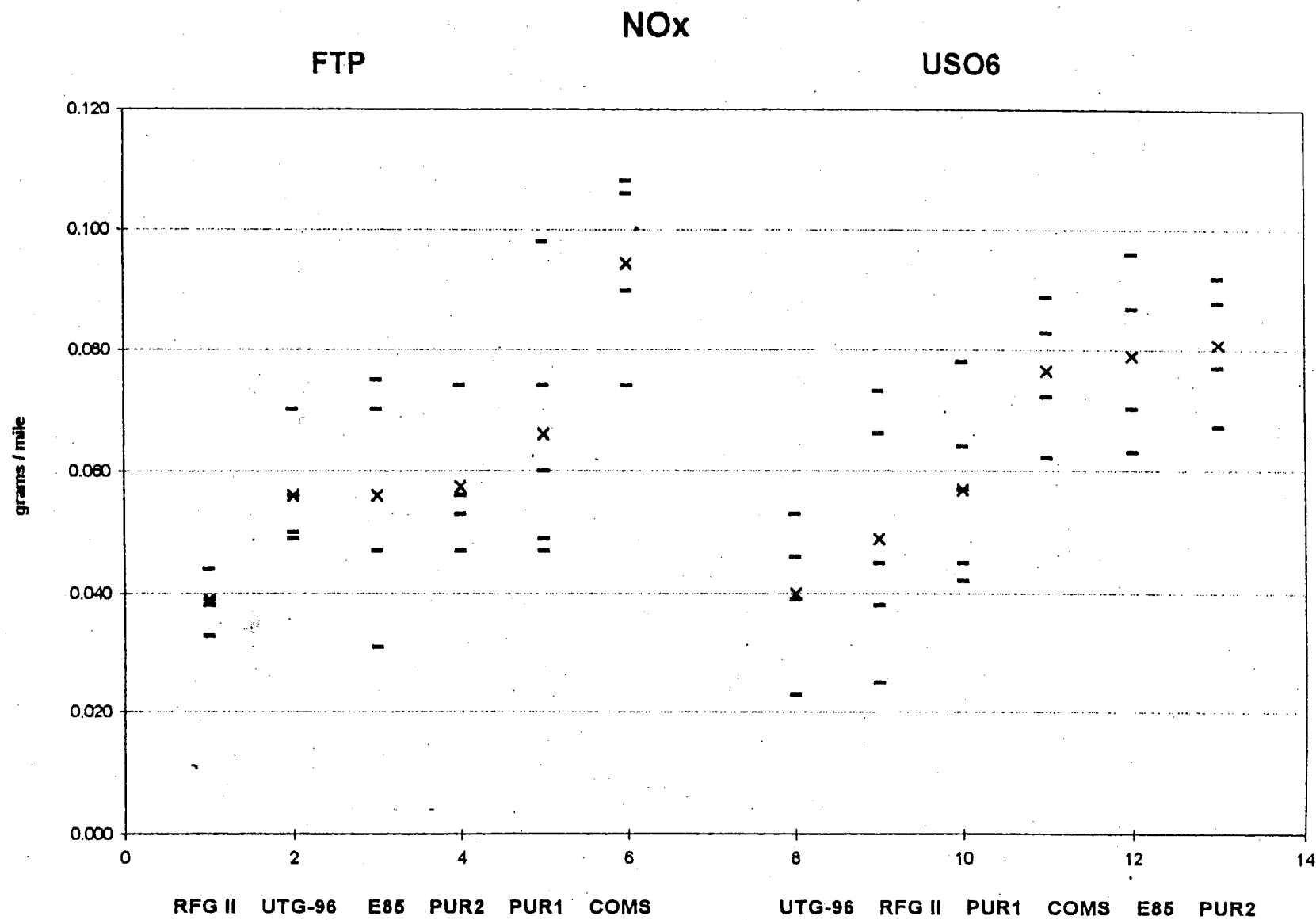
Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends. Tier I emissions standards for CO = 3.4 gram/mile.



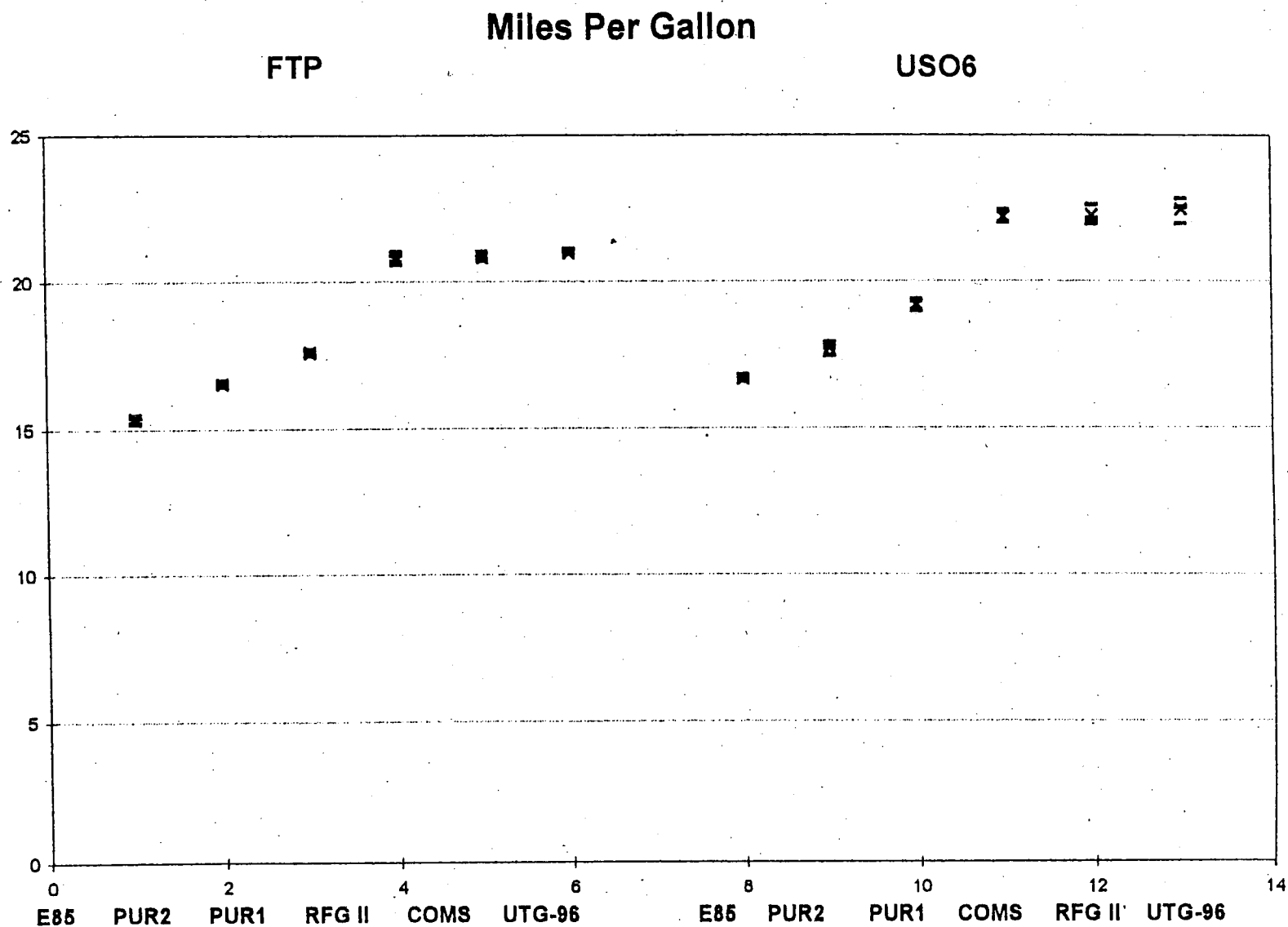
Carbon Dioxide



Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends



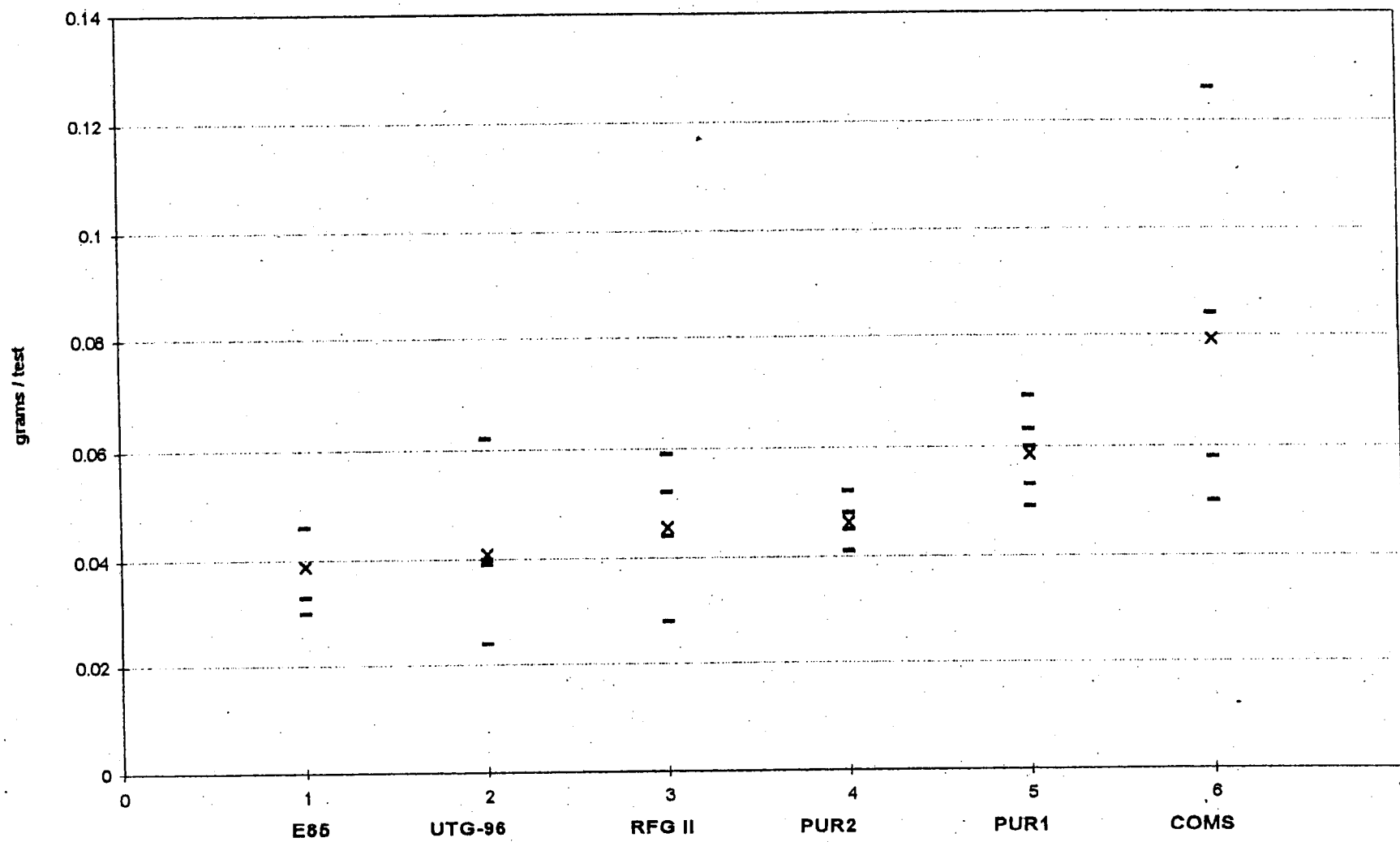
Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends. Tier I emission standard = 0.4 gram/mile.



Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends



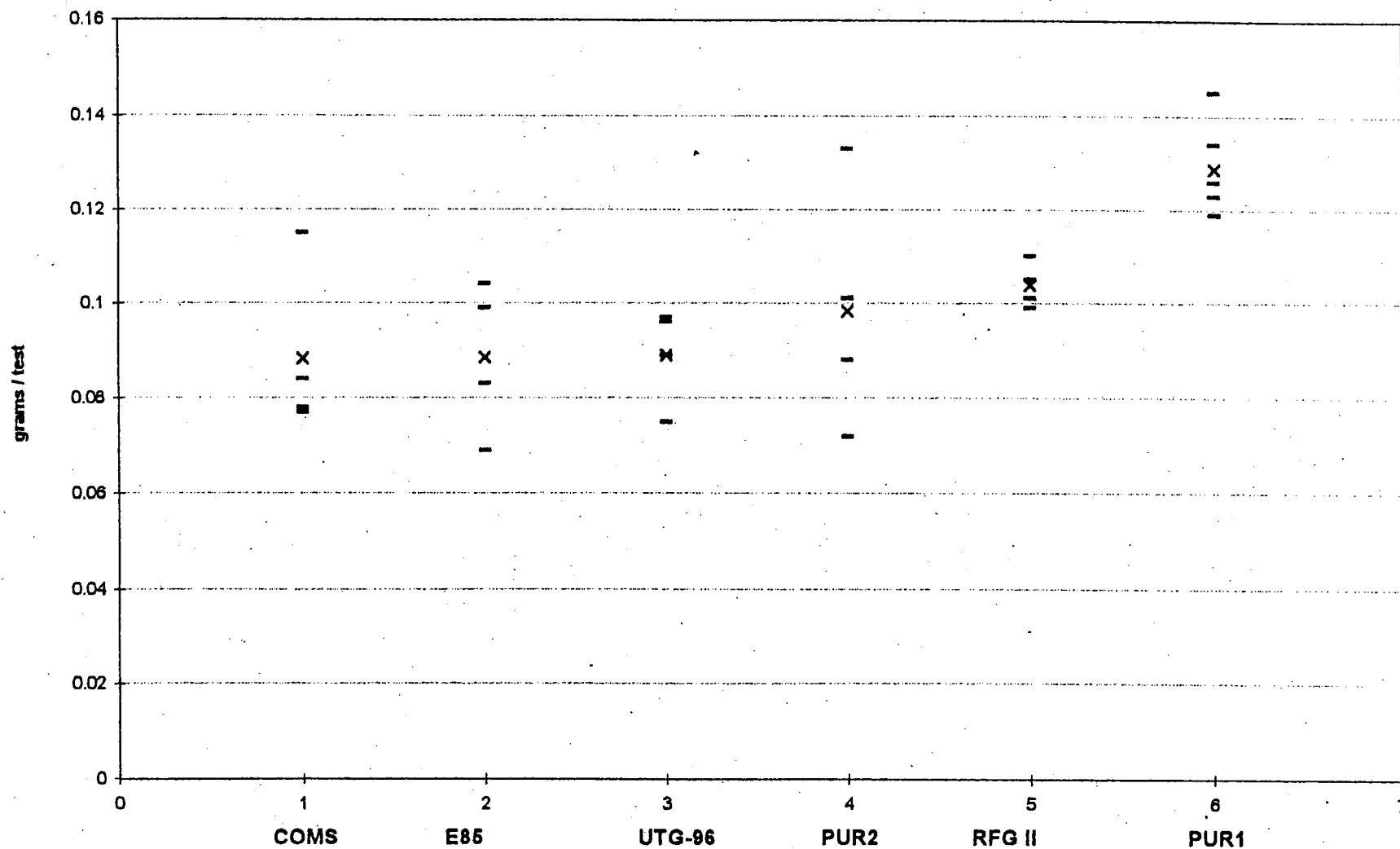
Diurnal



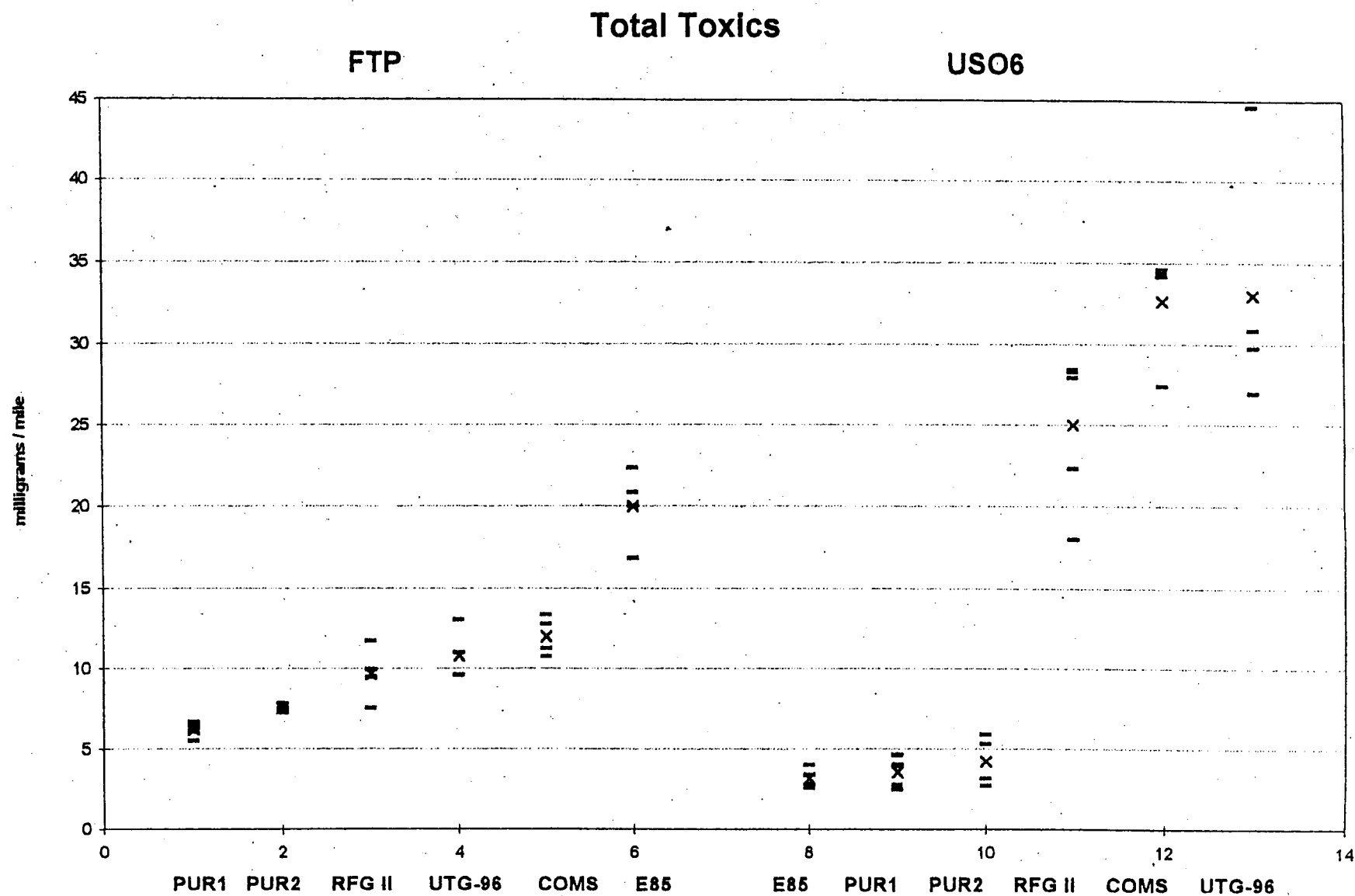
Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends



Hot Soak



Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends



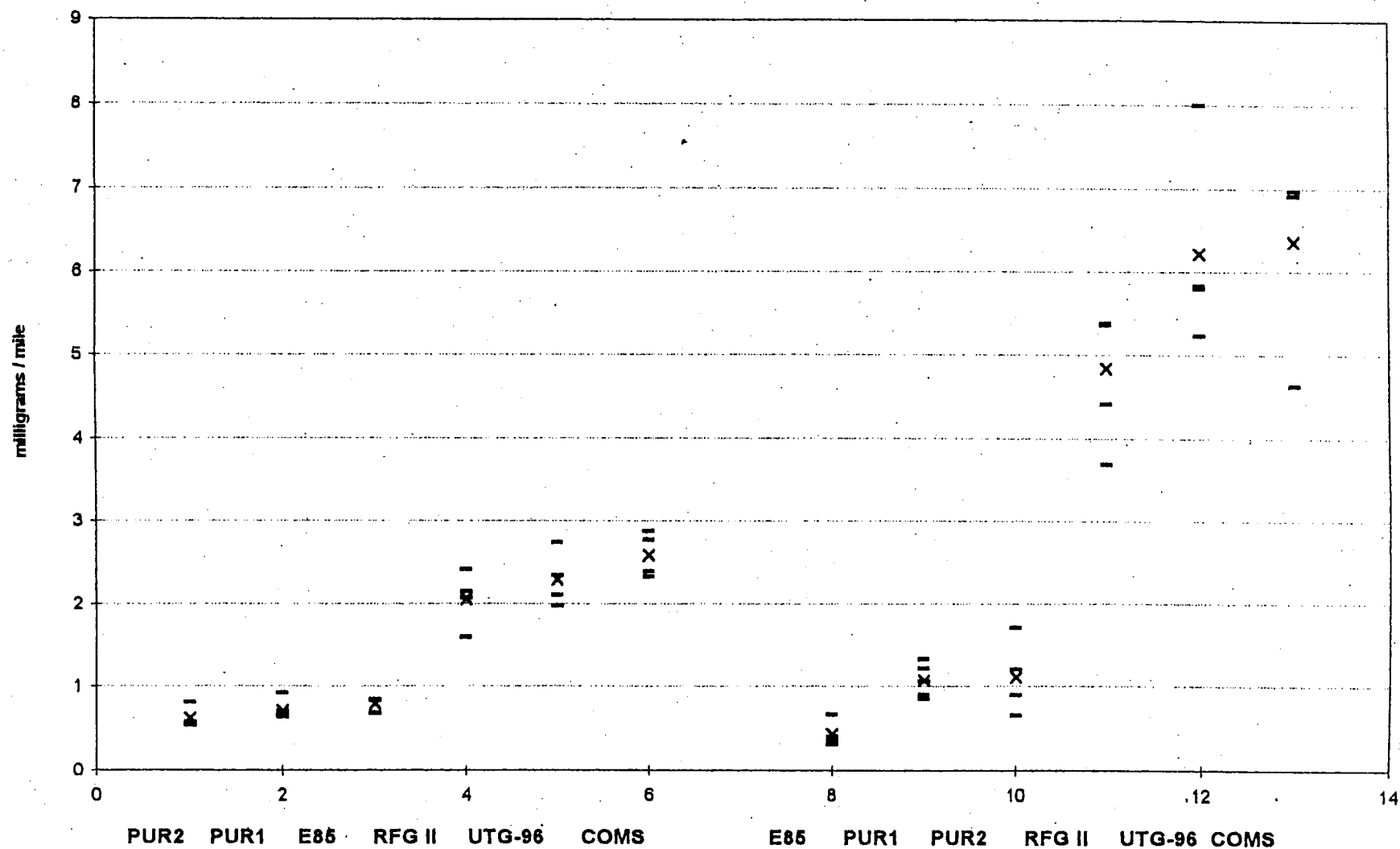
Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends



Potency Weighted Toxics

FTP

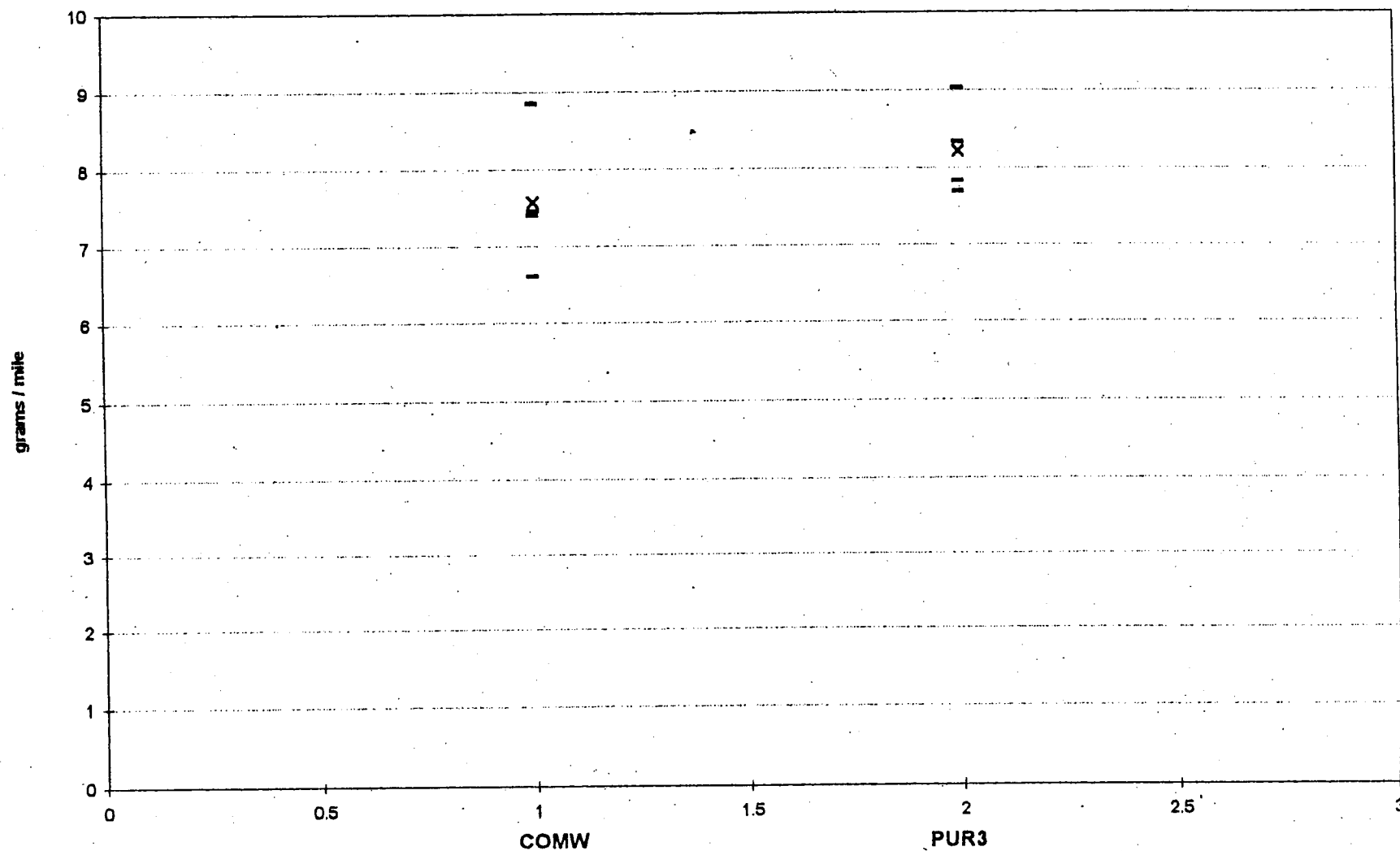
US06



Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE regular and premium blends



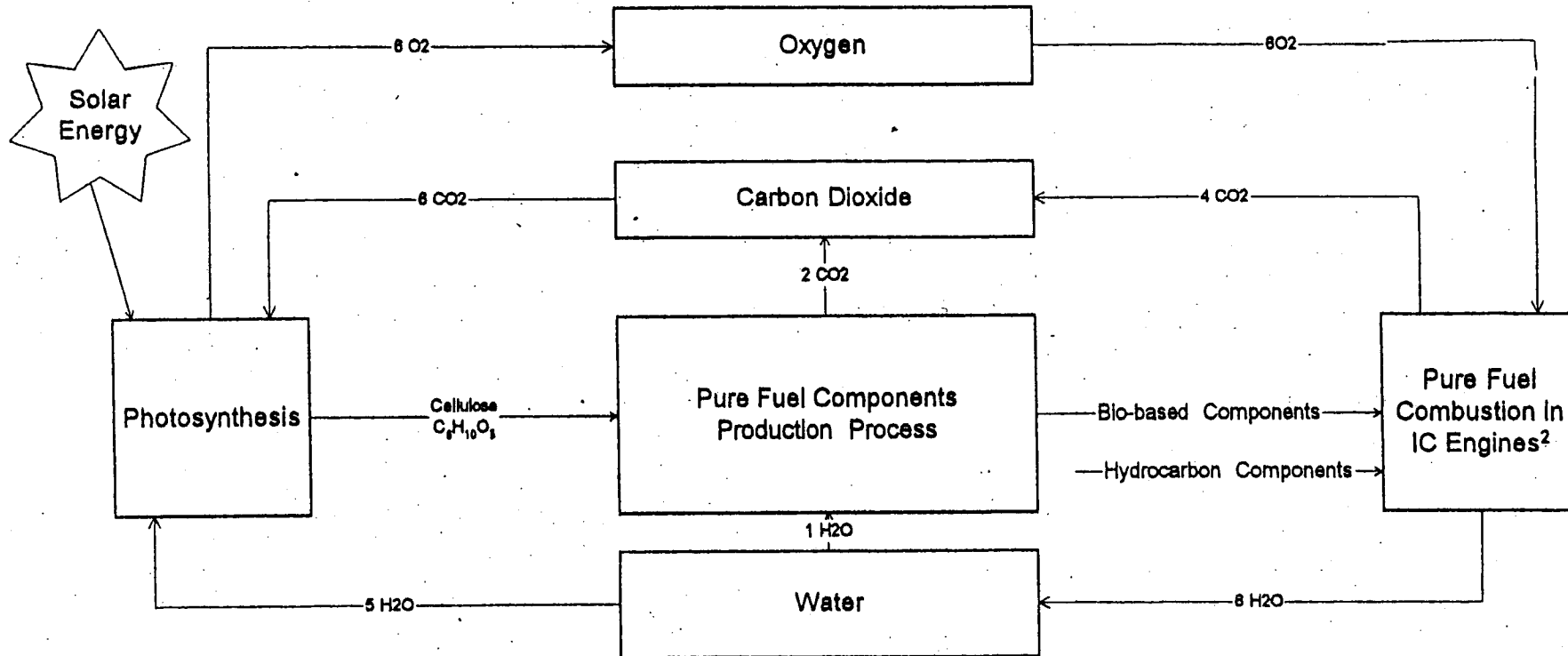
Cold Carbon Monoxide FTP



Tests performed on 1997 Ford Taurus E85 FFV at Automotive Testing Laboratories, Ohio. February - April 1997 on PURE cold weather blend. Tier I carbon monoxide emissions standard = 10 gram/mile

Carbon Dioxide Emissions¹

Life-Cycle Impact Assessment of Pure Fuel Production and Consumption



Total CO ₂ produced by burning 1 bgpy of RFG equivalent ³		Net CO ₂ Reduction from RFG		
	million tons		million tons	(%)
RFG	11.58			
Pure Regular	4.34	Pure Regular	7.24	(63)
Pure Premium	3.88	Pure Premium	7.70	(66)

1. Based on CO₂ only as it is the most significant component of GHG emissions.
2. Based on per gallon fuel combustion containing both biobased & hydrocarbon components.
3. Wang, M. Greet 1.3 Fuel Cycle Model, Argonne National Laboratory, May 1997.

C ii. Fuel Production Emissions

Integrated Ethanol/MTHF Process

	Feedstock Prod'n gram/gal	Fuel Prod'n gram/gal	Fuel Distribution gram/gal	Total Emissions gram/gal
VOC	0.164	2.730	1.209	4.104
CO	0.767	7.500	0.352	8.619
NOx	0.782	3.020	0.852	4.654
PM10	0.075	0.500	0.071	0.645
SOx	0.037	0.154	0.098	0.288
CH4	0.007	0.062	0.002	0.071
N2O	0.003	0.040	0.009	0.052
CO2	129.05	454.96	122.76	706.77
Total	130.88	468.97	125.36	725.20

Pentanes Plus Process

	Feedstock Prod'n gram/gal	Fuel Prod'n gram/gal	Fuel Distribution gram/gal	Total Emissions gram/gal
VOC	0.043	0.042	0.136	0.221
CO	0.434	0.015	0.040	0.489
NOx	0.595	0.178	0.096	0.870
PM10	0.066	0.060	0.008	0.133
SOx	0.606	0.271	0.011	0.888
CH4	0.033	0.088	0.000	0.121
N2O	0.033	0.000	0.001	0.034
CO2	563.333	49.016	13.82	626.17
Total	565.14	49.67	14.12	628.93

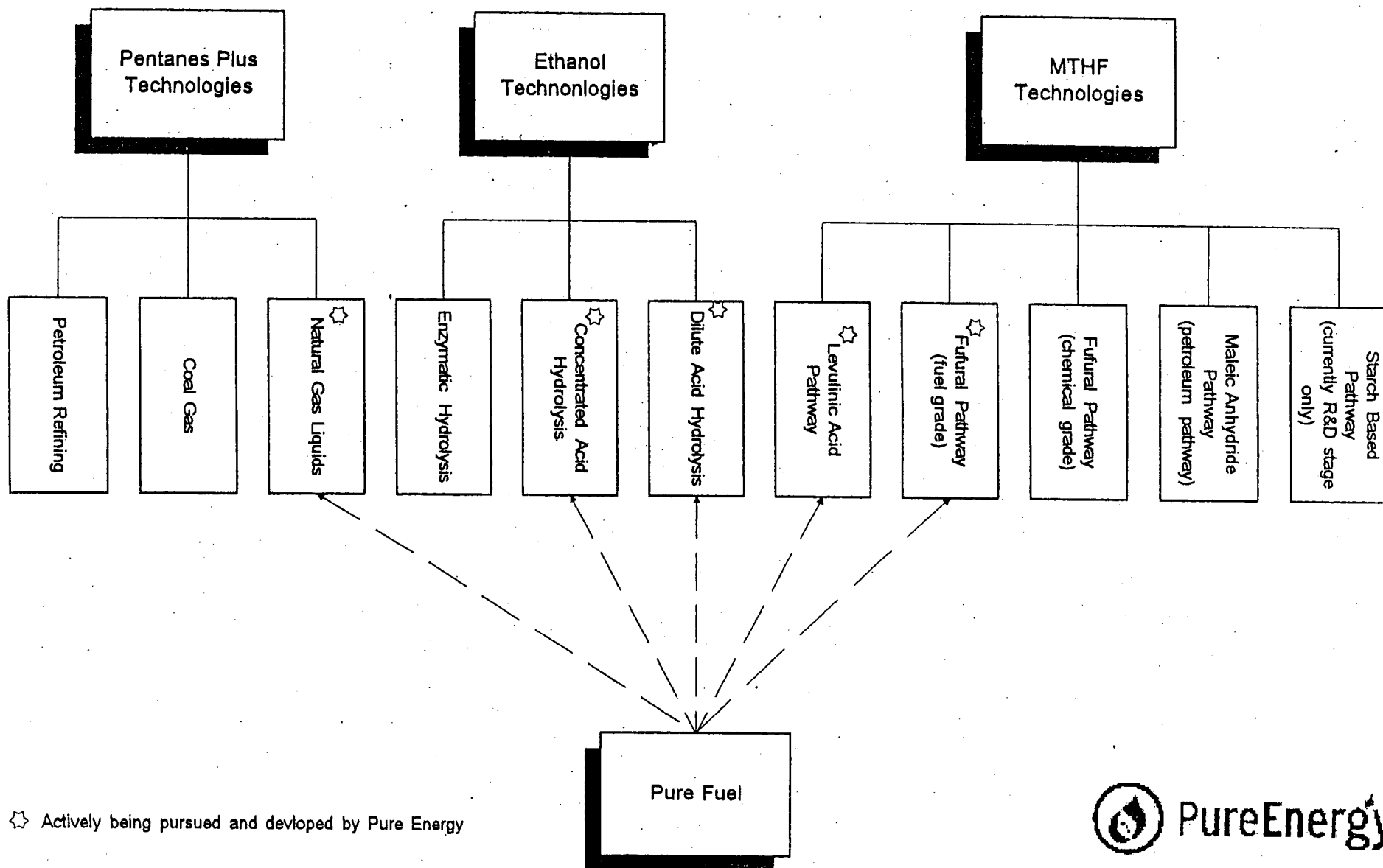
	Emissions from production of one gallon of Pure Fuel gram/gal	Emissions from production of one gallon of RFG gram/gal	Net Emissions Reductions	
	gram/gal	gram/gal	gram/gal	%
VOC	2.881	2.246	-0.635	-28%
CO	6.058	4.653	-1.405	-30%
NOx	3.462	4.202	0.740	18%
PM10	0.484	0.504	0.020	4%
SOx	0.477	3.150	2.673	85%
CH4	0.087	9.746	9.660	99%
N2O	0.046	0.144	0.098	68%
CO2	681.38	2,377.09	1,695.70	71%
Total*	694.88	2,401.73	1,706.86	71%

* Based on proprietary ratios of etoh, MTHF and Pentane Plus.

Total emissions from production of Pure Fuel are 71% less than from production of one gallon of RFG

Appendix D.

Production Technologies of Pure Fuel Components





Automotive Testing Laboratories, Inc.

June 27, 1997

Merrick Andlinger
PURE Energy Corporation
One World Trade Center, Suite #4573
New York, NY 10048

Dear Mr. Andlinger:

ATL has performed FTP tests and US06 tests per the Code of Federal Regulations, Book 40 Part 86 (where applicable regulations exists; where they do not, we have made logical extrapolations), from February through June, 1997, on two E85 1997 Ford Taurus FFVs for your company. The five fuels tested include California Phase 2 Reformulated Gasoline, E85 (85% chemical ethanol plus 15% California Phase 2 Reformulated Gasoline), and Federal Certification test fuel (UTG96) purchased from Phillips 66 Co., and blends of components supplied by Pure Energy. The commercial fuel tested was purchased from a local distributor of the Shell Oil Company.

Sincerely,

Wendy L. Clark
Manager, Program Development

● Corporate Offices
P.O. Box 289
East Liberty, Ohio 43319
513/666-4351
Fax 513/666-5391

● Arizona Laboratory
263 S. Mulberry St.
Mesa, Arizona 85202
602/649-7906
Fax 602/649-7905

● Ohio Laboratory
Located on Transportation
Research Center of Ohio
P.O. Box 289
East Liberty, Ohio 43319
513/666-4351
Fax 513/666-5391

Pure Energy Life Cycle Energy Analyses

	Biomass Ethanol	Corn Ethanol	
	Pure Energy Integrated Process	Pure Energy - US Department of Agriculture/AER - 721	Pure Energy - GREET 1.3 (ANL)
Total Energy Required to Produce One Gallon of Pure Fuel (Btu/gal of Pure Fuel)	76,034	87,464	80,757
Total Energy Output from Producing One Gallon of Pure Fuel and Co-Products (Btu/gal of Pure Fuel)	172,810	164,367	141,501
Net Energy Gain (Btu/gal of Pure Fuel)	96,777	76,902	60,743
Process Efficiency (Btus produced per Btu input)	2.27	1.88	1.75

Pure Energy Life Cycle Emissions Analysis

Corn Ethanol - GREET 1.3 (ANL) and Stand Alone MTHF Process

Pentanes Plus Process

Total Emissions from Production of One Gallon of Pure Fuel (A)

Total Emissions from Production of One Gallon of RFG (B)

Net Reduction in Emissions (B - A)

Percent Reduction from RFG

Corn Ethanol	
Total Emissions (gram/gal)	
	1,427 ¹
	<u>768</u>
	1,219
	<u>2,402</u>
	<u>1,183</u>
	49%

1. Total emissions from Corn Ethanol and MTHF Production are 6,943 gram/gal. Carbon sequestration absorbs 5,516 grams via photosynthesis from renewable feedstocks, thus net emissions from a Corn Ethanol and MTHF facility are 1,426 gram/gal.





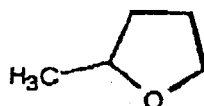
PureEnergy

Pure Energy Corporation
One World Trade Center
Suite 4573
New York, New York 10048
tel 212.938.6923
fax 212.839.0383

MTHF (2-Methyltetrahydrofuran) Chemical Description

MTHF is a currently produced and used as a specialty solvent derived mainly from renewable resources (corn cobs, sugar cane bagsasse, and oat hulls) via furfural pathway. It is used in a wide variety of applications ranging from organometallic reactions to non-electrolytic lithium batteries to serving as a chemical intermediate. Pure Energy is working on an alternate chemical pathway (via levulinic acid based on six-carbon sugar as supposed to five-carbon sugar based furfural pathway) to produce fuel-grade MTHF more economically than current technology.

MTHF Chemical Scheme (Molecular Formula: $C_5H_{10}O$)



MTHF has been tested extensively for its suitability as a fuel for light-duty engines.¹ MTHF is pipeline-fungible with hydrocarbons and has a carbon weight percent comparable to gasoline. Unlike other chemicals in furan series, MTHF has physical and chemical characteristics that are environmentally and toxicologically similar to gasoline. It is a chemically stable substance.

MTHF Physical and Chemical Properties

Energy Content (net heating value)	~110,000 BTUs per gallon
Molecular Weight	86.13 g/mol
Color	Water-white
Odor	Ethereal
Evaporation Rate	4.2 (n-Butyl Acetate = 1)
Flash Point	-11°C
Boiling Point	80°C
Freezing Point	-136°C
Specific Gravity	0.855 (20/20°C)
Autoignition Temperature	270°C
Dielectric Constant	7.0 (at 25°C)

FOR MORE INFORMATION ON MTHF CONTACT: Irshad Ahmed
VP & Chief Science Officer

¹ Lucas, S.V., et. al., "Exhaust Emissions and Field Trial results of a New, Oxygenated, Non-Petroleum-Based, Waste-Derived Gasoline Blending Component: 2-Methyltetrahydrofuran," SAE Technical Paper No. 932675.



SEP 25 1998

PureEnergy™

September 24, 1998

Pure Energy Corporation
One World Trade Center
Suite 4573
New York, New York 10048
tel 212.938.6923
fax 212.839.0383
www.pure-energy.com

U.S. Department of Energy
Office of Transportation Technologies
EE-34, Docket no. EE-RM-98-PURE
1000 Independence Avenue, SW
Washington DC 20585

Re: Alternative Fuel Transportation Program;
P-Series Fuels
Docket No. EE-RM-98-PURE
Additional Comments of Pure Energy Corporation

Please include the enclosed data table with the submission by Pure Energy Corporation on September 16, 1998. The charts sent in the September 16 comment are based on data from this table.

Very truly yours,

Merrick G. Andlinger
Merrick G. Andlinger

President & CEO

PureEnergyTM

September 16, 1998

Pure Energy Corporation
One World Trade Center
Suite 4573
New York, New York 10048
tel 212.938.6923
fax 212.839.0383
www.pure-energy.com

U.S. Department of Energy
Office of Transportation Technologies, EE-34
Docket No. EE-RM-98-PURE
1000 Independence Avenue, S.W.
Washington, DC 20585

Re: Alternative Fuel Transportation Program;
P-Series Fuels
Docket No. EE-RM-98-PURE
Comments of Pure Energy Corporation

SUMMARY: Pure Energy Corporation ("Pure") commends the Department of Energy for promulgating a Notice of Proposed Rulemaking ("NOPR") in response to the petition filed by the company, seeking designation of its P-Series fuels as an 'alternative fuel' under section 301(2) of the Energy Policy Act of 1992.¹ The NOPR appropriately states: "Obviously, a fuel that is more than 50 percent non-petroleum in energy equivalent terms is 'mainly' and therefore 'substantially not petroleum.'"² Yet the NOPR goes on to propose designation of the P-Series blends only if their energy content is at least 60 percent non-petroleum, noting that the examples in Pure's petition all met that standard. Pure believes a 50 percent minimum non-petroleum energy content is the right standard as a matter of law and public policy, and with this submission Pure provides additional emissions testing data on P-Series blends in support of that conclusion.

¹ Public Law 102-486, codified at 42 U.S.C. 13211(2).

² *Federal Register*, Vol. 63, No. 144, July 28, 1998, p. 40204.



I. CHARACTERISTICS OF THE FUEL

As noted in the petition filed by Pure on June 30, 1997, P-Series fuels will be produced by blending ethanol and MTHF derived from cellulosic biomass in varying proportions with pentanes plus (expected to be derived from natural gas liquids). As stated therein at page 7, the fuel blends described were "intended to represent options within possible blending ranges – of pentanes plus, from 10 percent to 50 percent by volume; MTHF, from 15 percent to 55 percent; ethanol, from 25 percent to 55 percent; and butane, from zero to 15 percent." These proportions were consistent with the ranges provided (and approved) in Pure's patent application for the fuels. Three representative blends were tested last year, and the results were described in Pure's petition. An alternative midgrade formulation that falls within these blending ranges is described below as another example of the P-Series fuel concept.

It should also be noted that the butane option described above (provided in order to assure adequate vapor pressure for cold starts in winter months) is not likely to consist of a separately added component. Instead, the characteristics of the pentanes stream will be varied to obtain the desired RVP value, leading to a higher butane content in the blend.

As noted in the petition at page 10, "both the ethanol and the MTHF will be derived from renewable resources.... The pentanes plus are expected to come exclusively from natural



gas liquids.... Thus, the fuel is expected to be entirely non-petroleum.” However, because the source of the pentanes plus cannot be assured in advance, Pure has not relied on them to demonstrate the fuel’s non-petroleum nature. Rather, it has considered only the renewable components of the fuel in meeting the law’s requirement that an alternative fuel must be substantially not petroleum.

II. DEFINITION OF “SUBSTANTIALLY”

The NOPR notes that “neither section 301(2) nor any other provision of EPACT states specifically or indicates how to measure whether a new fuel ... is ‘substantially not petroleum.’”³ In discussing standard definitions of the term “substantially,” the NOPR observes, “Obviously, a fuel that is more than 50 percent non-petroleum in energy equivalent terms is ‘mainly’ and therefore ‘substantially not petroleum.’”⁴ Noting that blends not meeting that 50 percent test might still be considered “substantially not petroleum,” the NOPR concludes, “Since the petition does not involve fuels that are less than 50 percent non-petroleum, in terms of energy content, it is unnecessary to address this policy question in this rulemaking.”⁵

³ Ibid., p. 40203.

⁴ Ibid., p. 40204.

⁵ Ibid.



However, the language of the proposed rule then describes P-Series fuels as “containing at least 60 percent non-petroleum energy content”⁶ – based on Pure’s statement in its petition, at page 10, that its fuels will be at least 60 percent non-petroleum. Since the petition was filed, Pure has engaged in further research and testing of additional blends that fall within the broader framework of its patent, as described above. Some of these blends would be lower in renewable content than the blends described in the petition, and the flexibility to market such blends to meet particular seasonal driving conditions would be very desirable. Accordingly, Pure recommends that the final rule stipulate that P-Series fuels must contain at least 50 percent non-petroleum energy content.

III. ENVIRONMENTAL CONSIDERATIONS

EPACT requires that an alternative fuel have “substantial environmental benefits.” The P-Series fuels contain essentially no undesirable olefins, sulfur, or aromatics, such as benzene. As a result, they have very clean emissions characteristics. In its petition, at page 12, Pure reported that P-Series fuels have “favorable emission characteristics relative to both conventional and reformulated gasoline, as well as E-85. In addition, [they reduce] greenhouse gas emissions by nearly two-thirds compared to gasoline.”

⁶ Ibid., p. 40208.



In light of the change suggested above with regard to non-petroleum energy content, Pure elected to engage in additional emissions testing of a representative summer midgrade blend to determine its environmental characteristics. The results of this testing are attached to these comments. The tested blend contained the following components:

Pentanes plus	43.0% by volume
MTHF	19.5%
Ethanol	37.5%
Renewable energy content by BTU	52.3%

Tests of this new midgrade blend were performed by Automotive Testing Laboratories near Columbus, Ohio, from July to September 1998 on two standard, unmodified 1997 Ford Taurus E-85 FFVs, using fuel blended from commercially available components that were purchased for that purpose. The vehicles were the same ones used to test the blends described in Pure's original petition.

The midgrade blend's emissions were compared to UTG-96, a non-oxygenated test reference gasoline, under the conditions prescribed by the Federal Test Procedure⁷. The same protocol was used in testing several P-Series blends last year against gasolines and other alternative fuels. The results were consistent with the environmental benefits over

⁷ *Code of Federal Regulations*, title 40, part 86.



gasoline (i.e., UTG-96) demonstrated by the original blends, albeit by a slightly lower margin. More specifically, as shown in the attached charts:

- Emissions of non-methane hydrocarbons from the midgrade blend were one-third lower than those from UTG-96, consistent with last year's results.
- CO and CO₂ emissions were once again lower for the P-Series blend than for UTG-96.
- NO_x emissions, while slightly higher on average for the midgrade blend than for UTG-96, varied by vehicle: They were very similar on one car, somewhat higher on the other.

Clustering the results leads to the following conclusions:

- The ozone-forming potential of the P-Series midgrade blend (a calculation based on the emissions to estimate the tendency of emissions to contribute to ozone formation) was more than one-third lower than UTG-96, a result similar to the original blends.

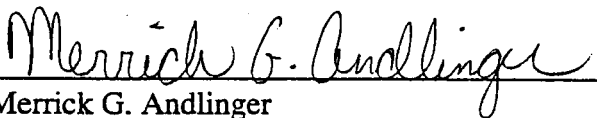


- Potency-weighted toxics from the midgrade blend were more than two-thirds lower than from UTG-96, again very similar to the reduction demonstrated last year by the other P-Series blends.

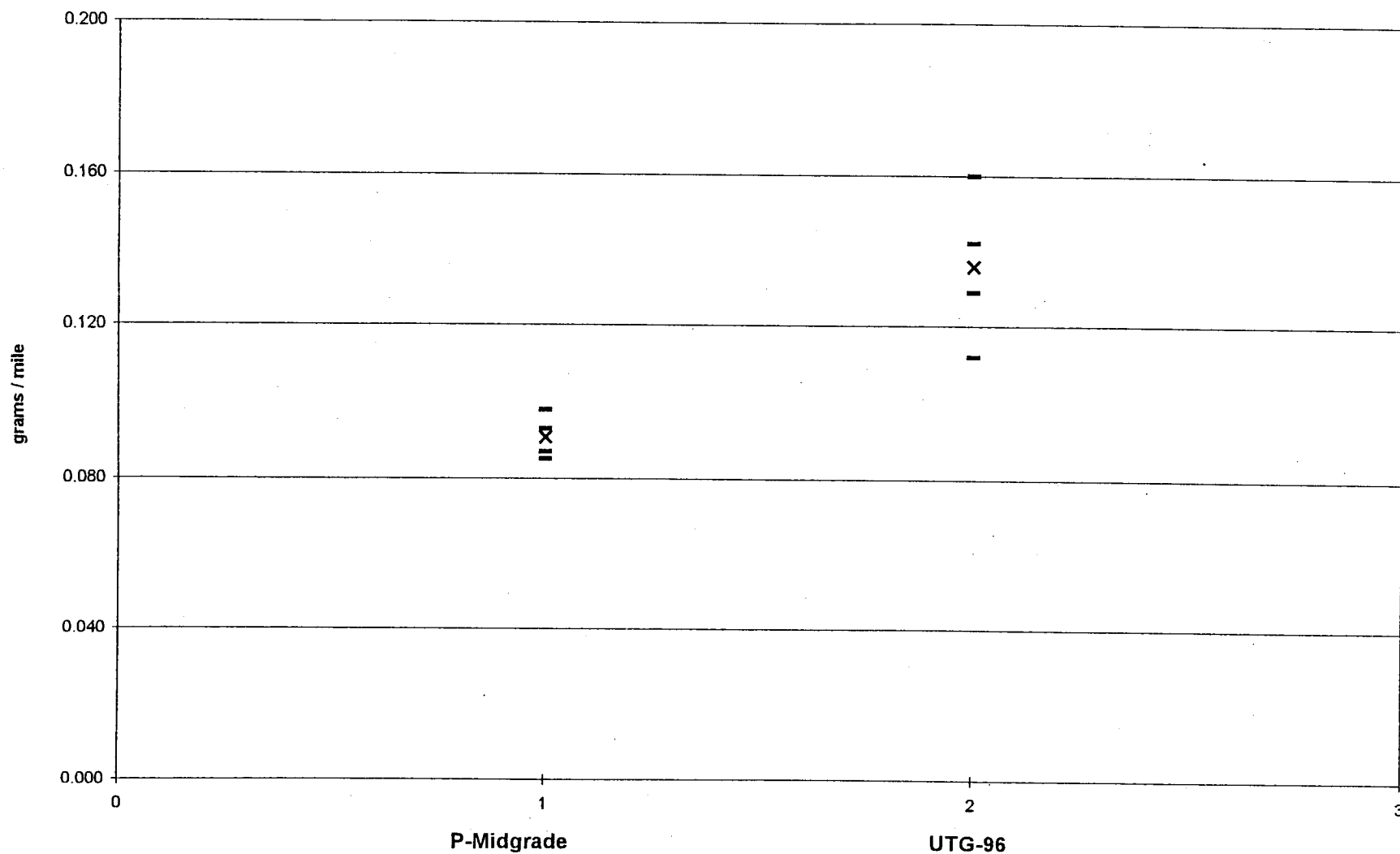
IV. CONCLUSION AND RECOMMENDATION

The NOPR appropriately justifies a 50 percent minimum non-petroleum energy content as an unassailable standard for an alternative fuel under the EPACT criteria, and Pure supports that conclusion as a matter of law and public policy. With this submission Pure provides additional emissions testing data on a P-Series blend that would benefit from a reconsideration of the 60 percent standard set forth in the NOPR. These data support alternative fuel designation at the 50 percent level. Accordingly, Pure respectfully requests and recommends that the final rule set a minimum non-petroleum energy content for P-Series fuels at 50 percent, not the 60 percent level proposed in the NOPR.

Submitted the 16th day of September, 1998.


Merrick G. Andlinger
President and Chief Executive Officer
Pure Energy Corporation

Non-Methane Hydrocarbon Equivalent (NMHCE)

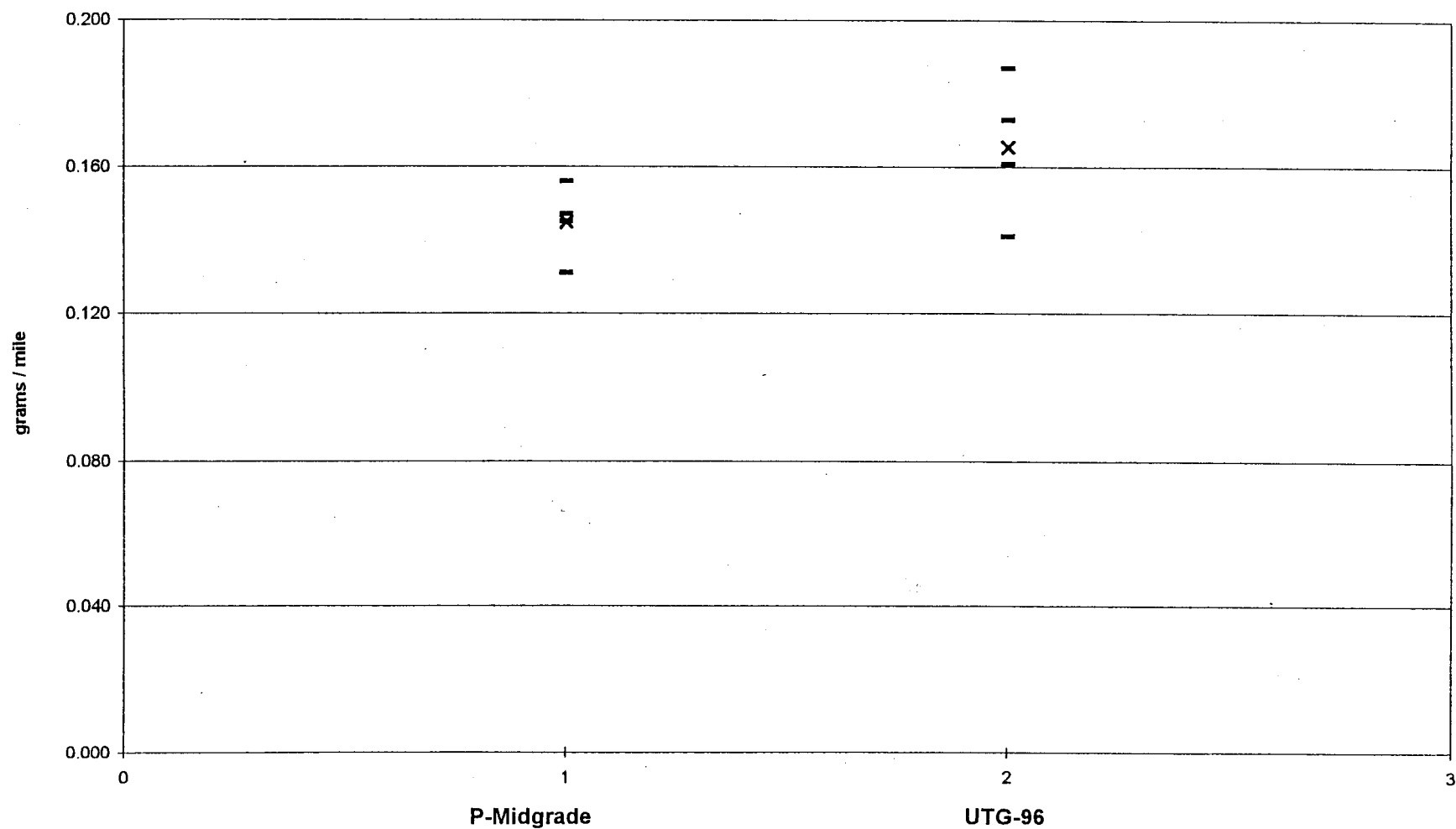


Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and UTG-96. Emissions from UTG are NMHC.

Tier I emissions standard for NMHC = 0.25 gram/mile.



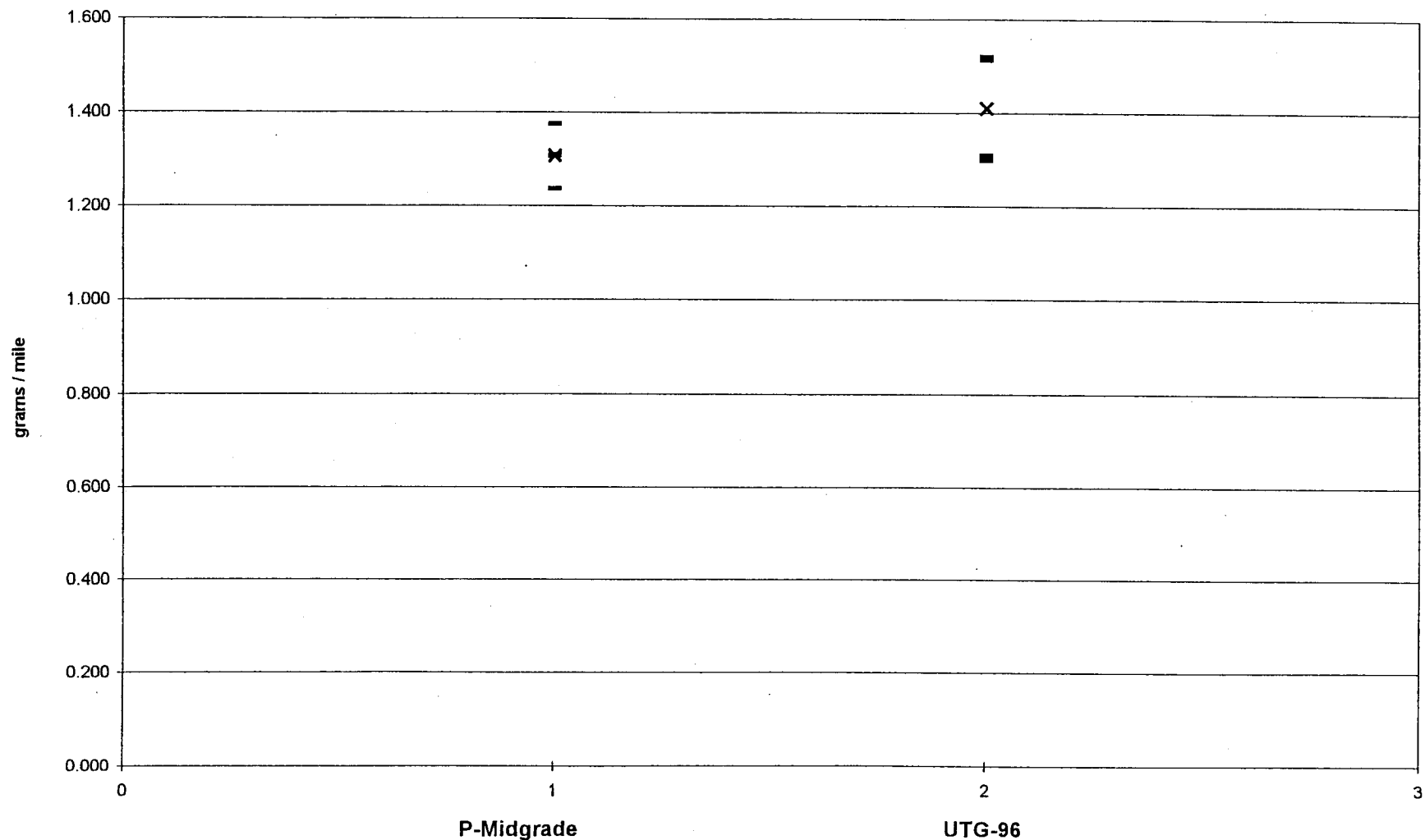
Total Hydrocarbon Equivalent (THCE)



Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and UTG-96. Emissions from UTG are THC.



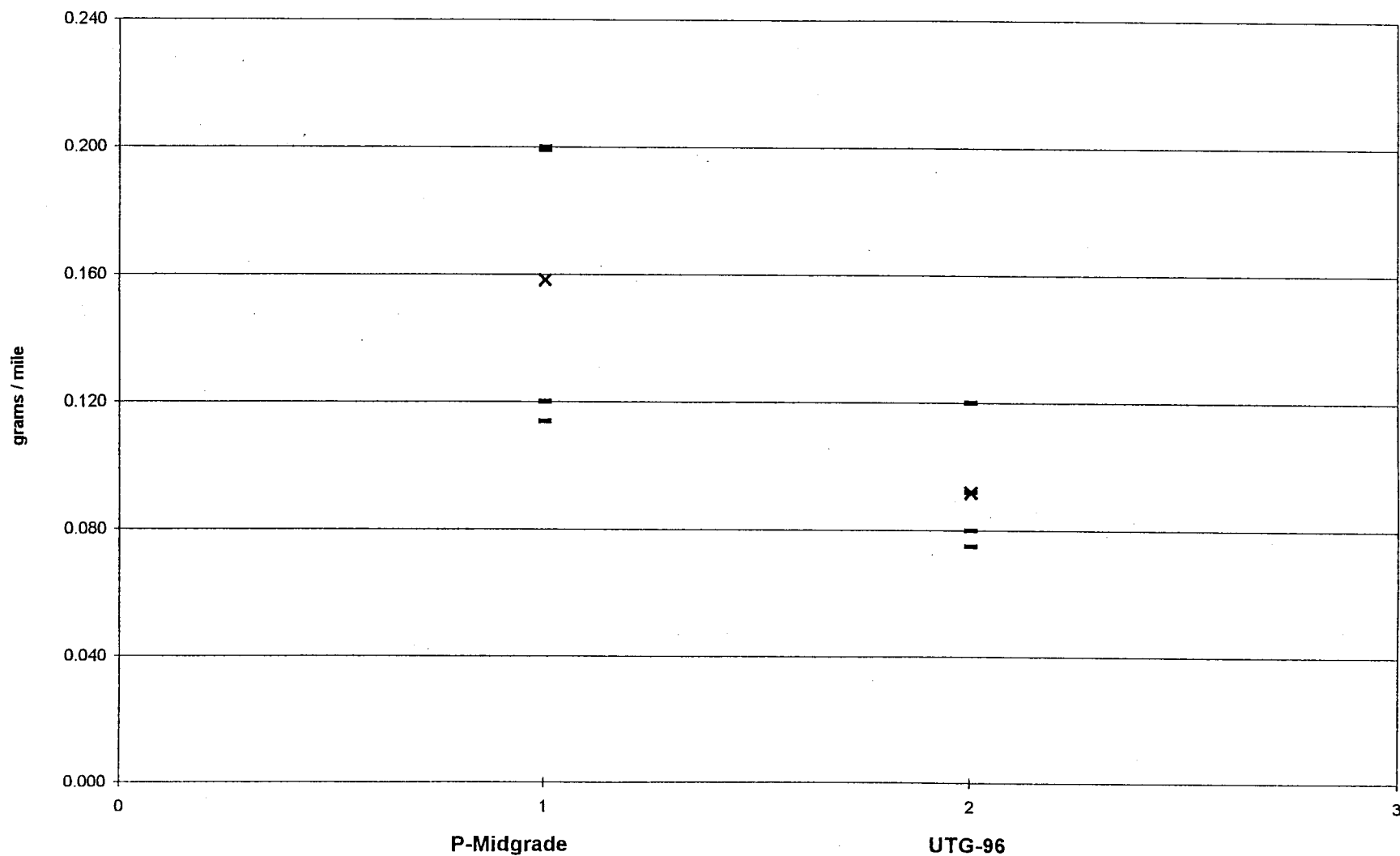
Carbon Monoxide (CO)



Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and UTG-96.

Tier I emissions standard for CO = 3.4 gram/mile.

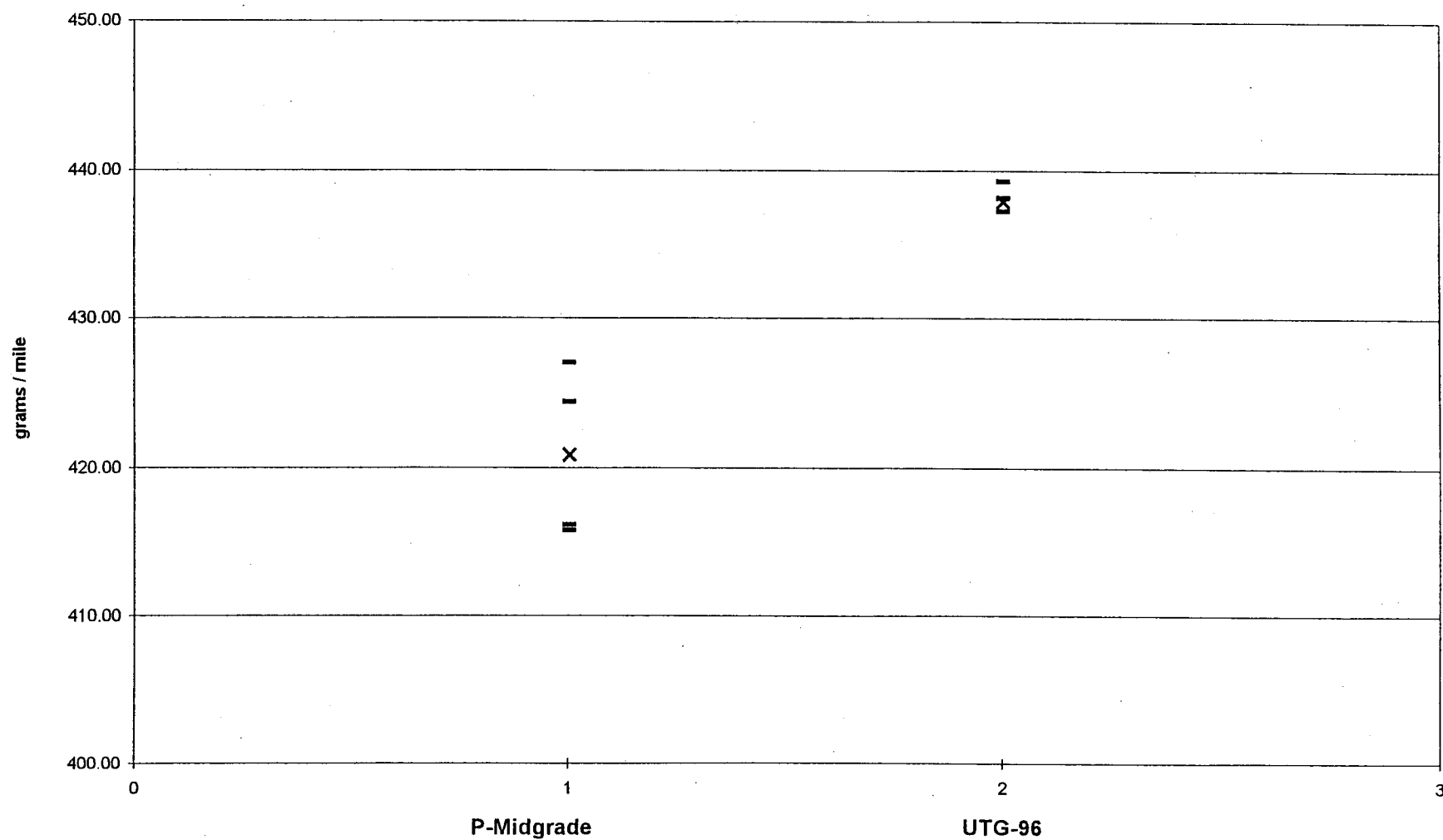
NOx



Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and UTG-96.

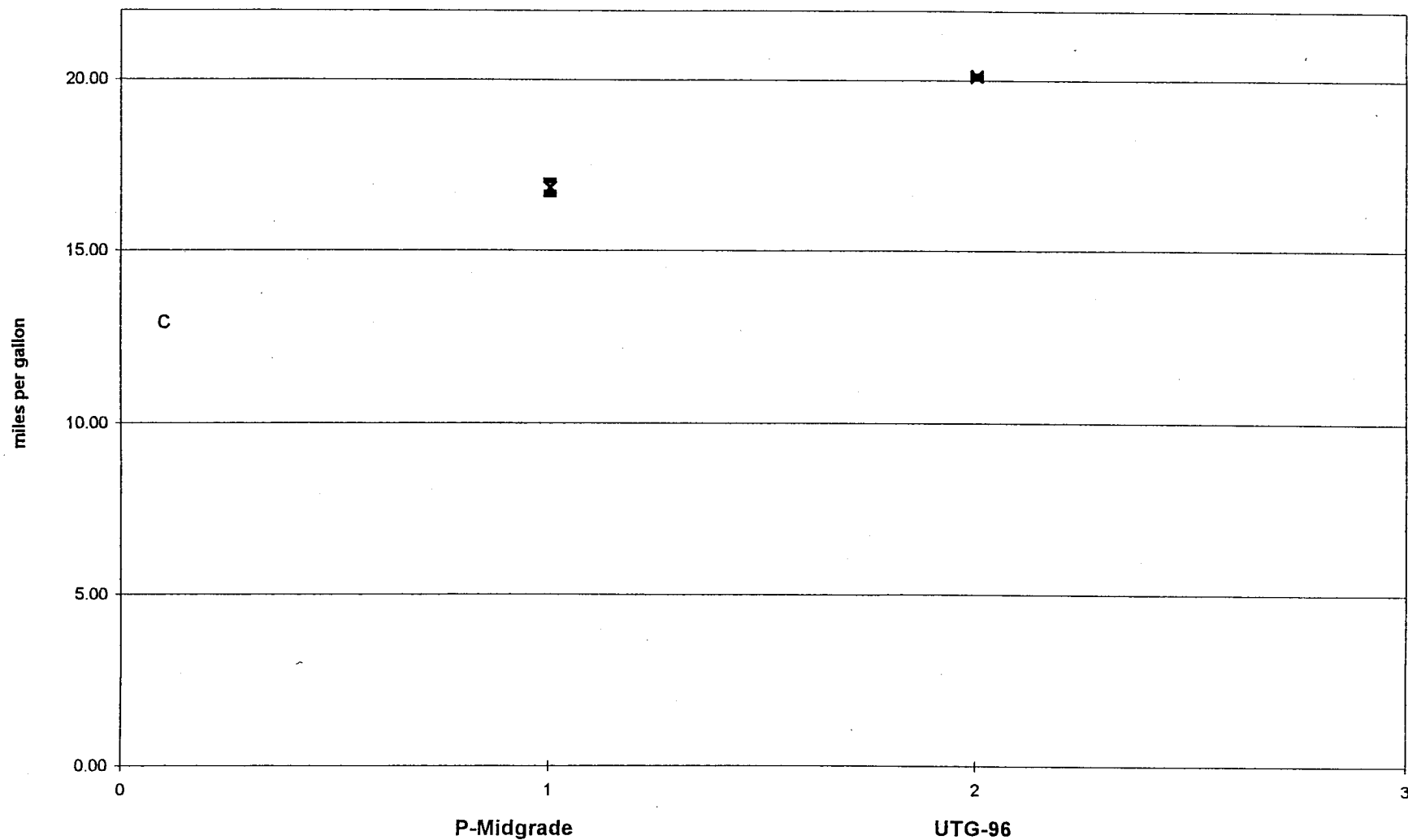
Tier I emissions standard for NOx = 0.4 gram/mile.

Carbon Dioxide (CO₂)



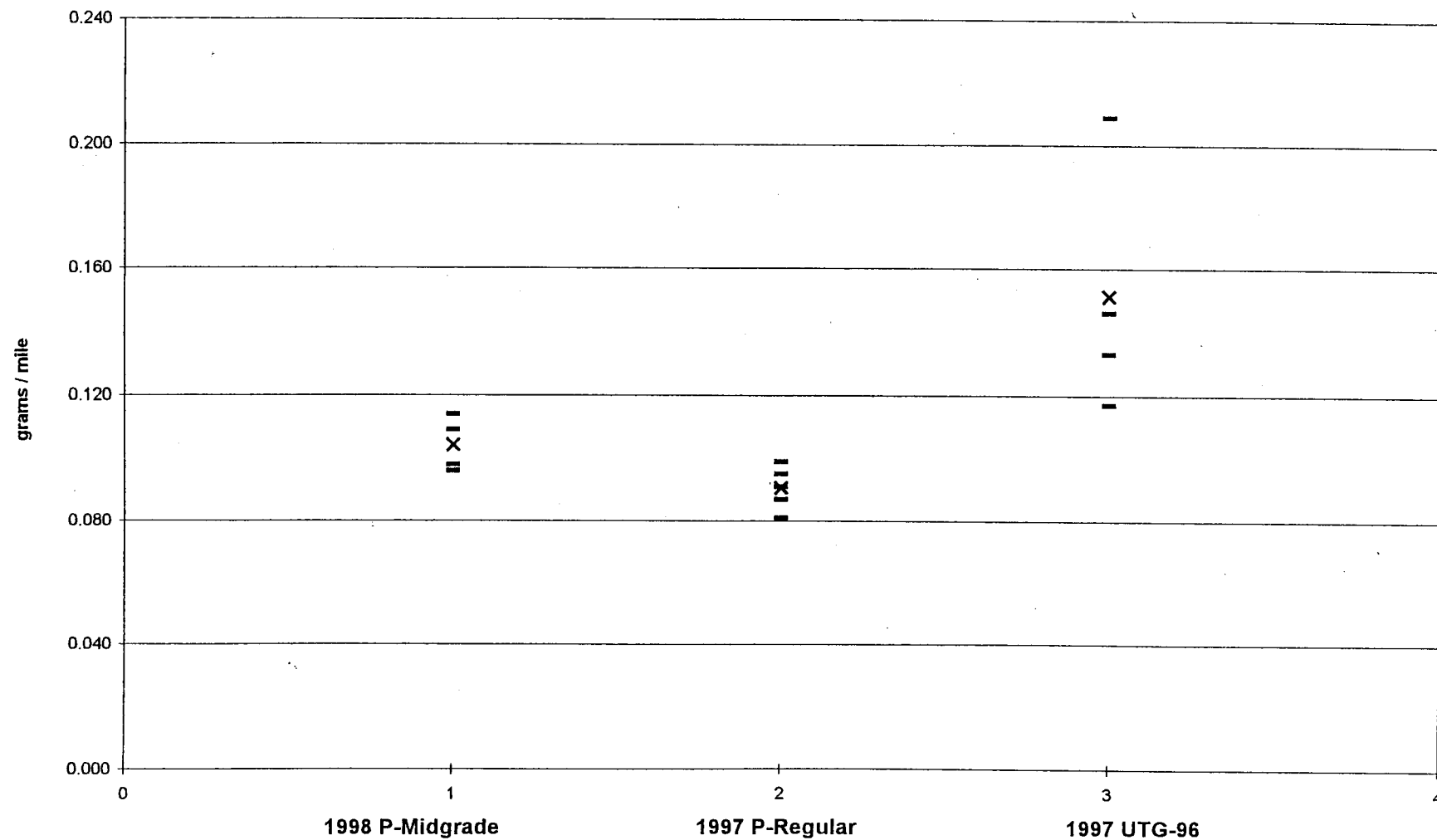
Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and UTG-96.

Fuel Economy



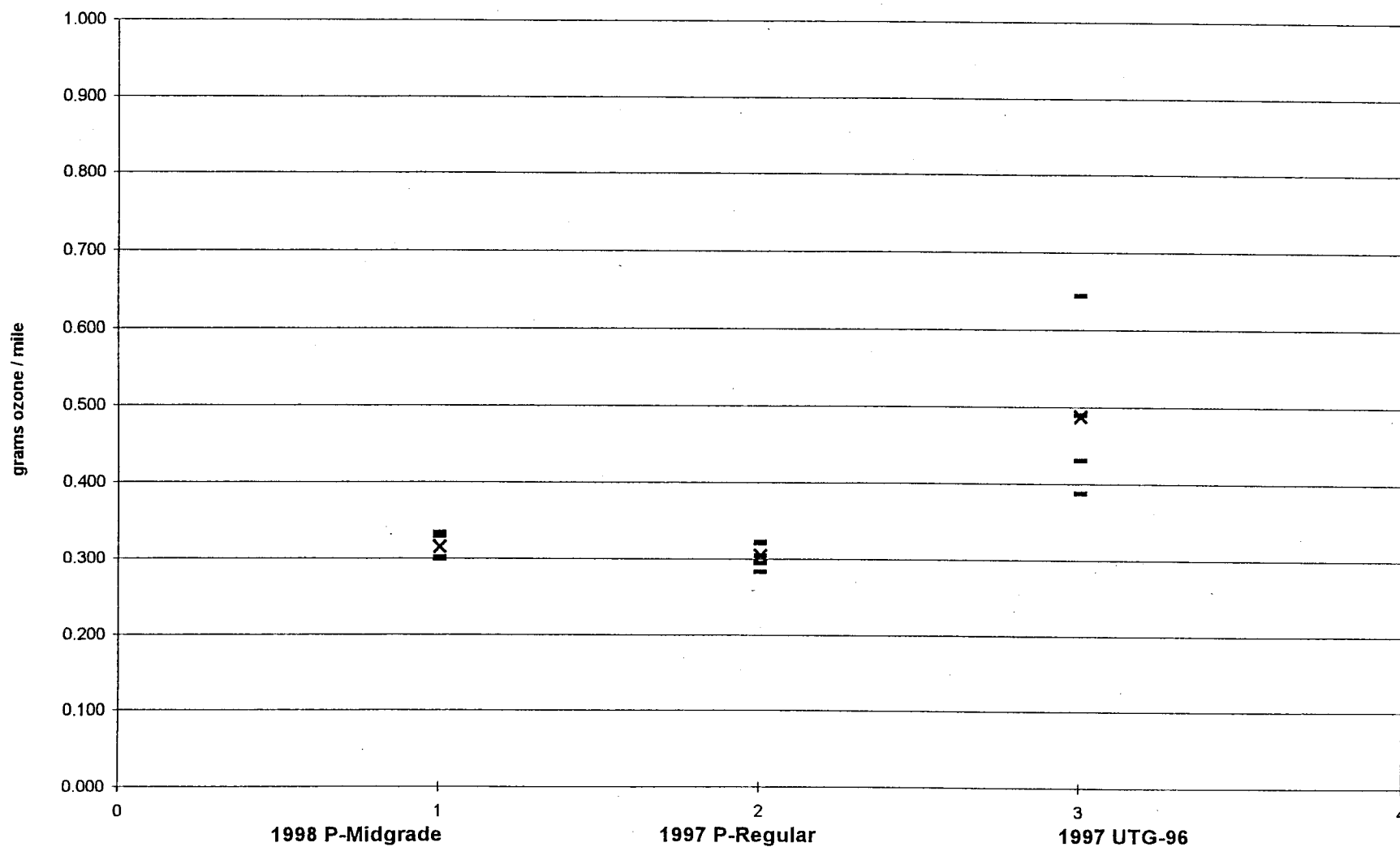
Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and UTG-96.

1998 Vs. 1997 Non-Methane Organic Gases (NMOG)



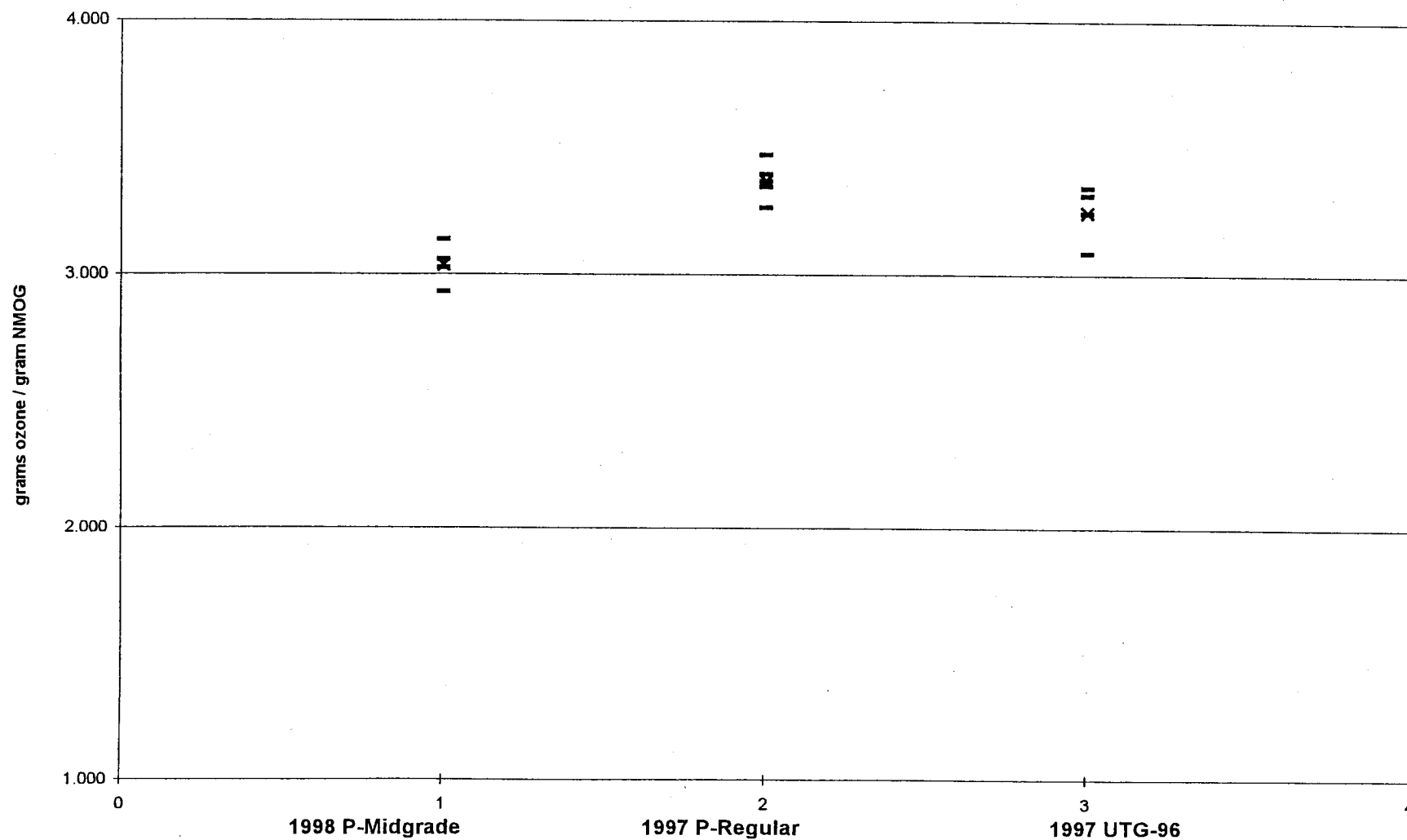
Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and February - June 1997 on P-Series regular and UTG-96.

1998 vs. 1997 Ozone Forming Potential (OFP)



Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and February - June 1997 on P-Series regular and UTG-96.

1998 Vs. 1997 Specific Reactivity

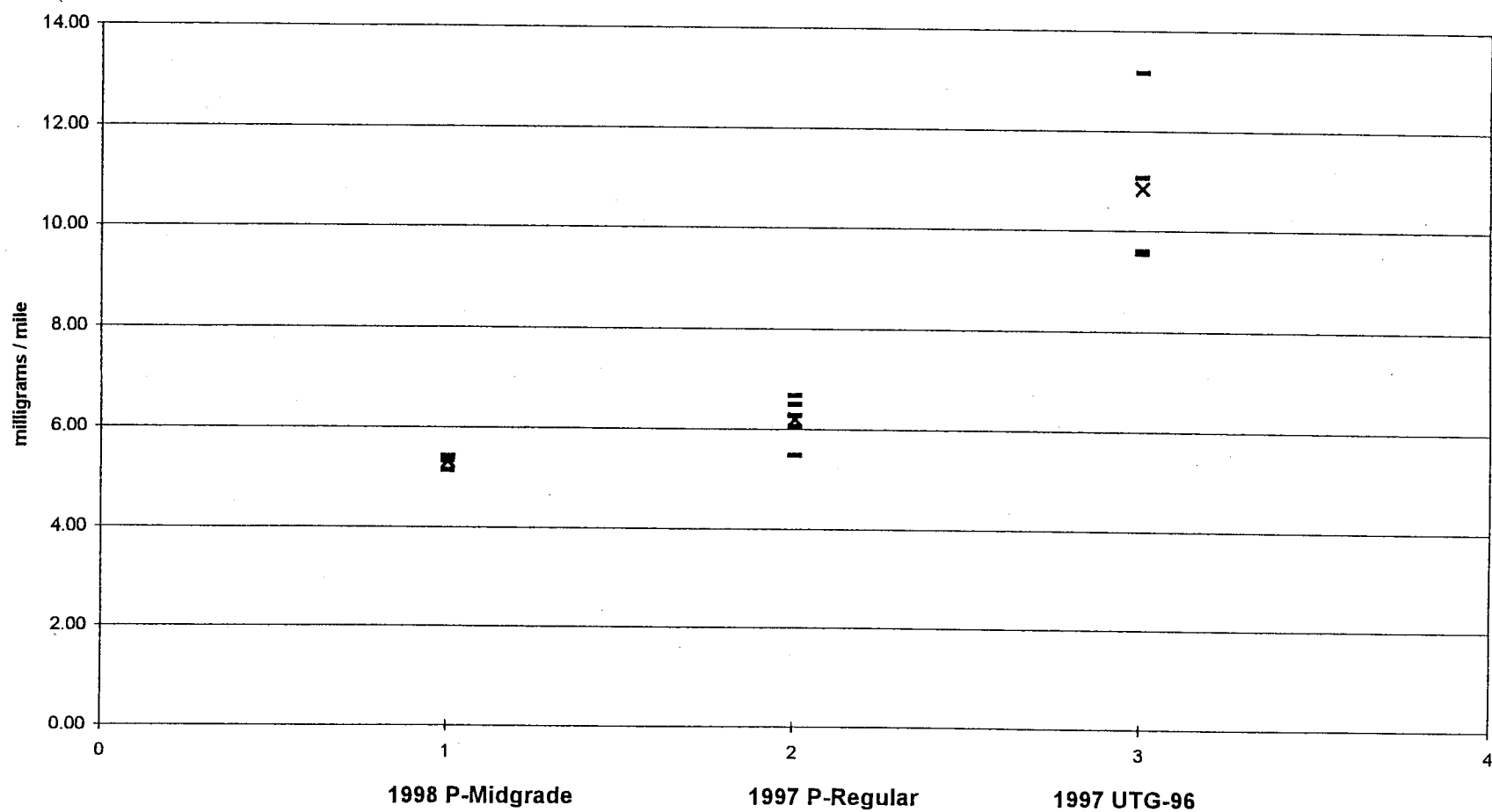


Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and February - June 1997 on P-Series regular and UTG-96.



1998 Vs. 1997 Toxic Emissions -

Total Toxics

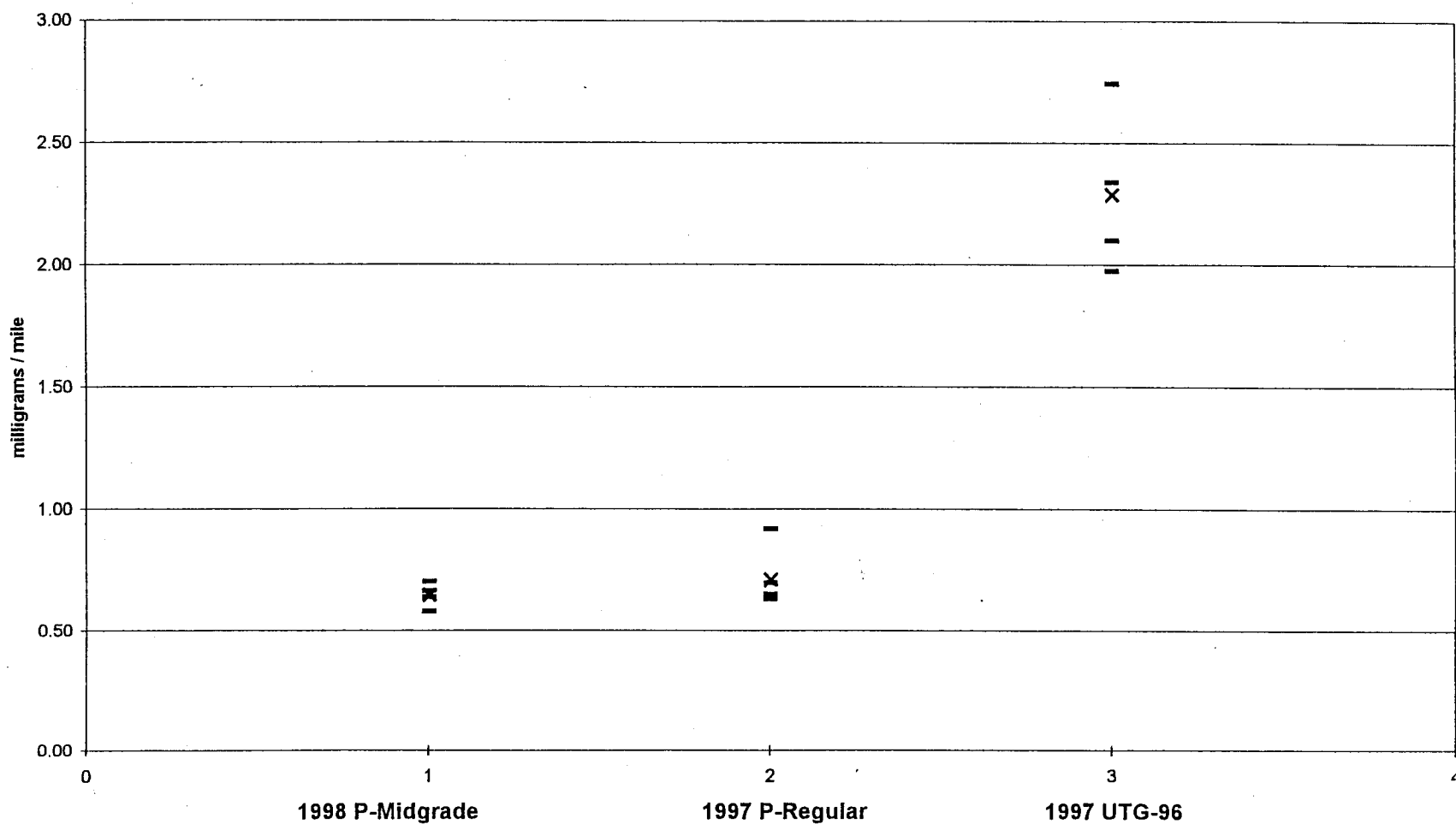


Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and February - June 1997 on P-Series regular and UTG-96.



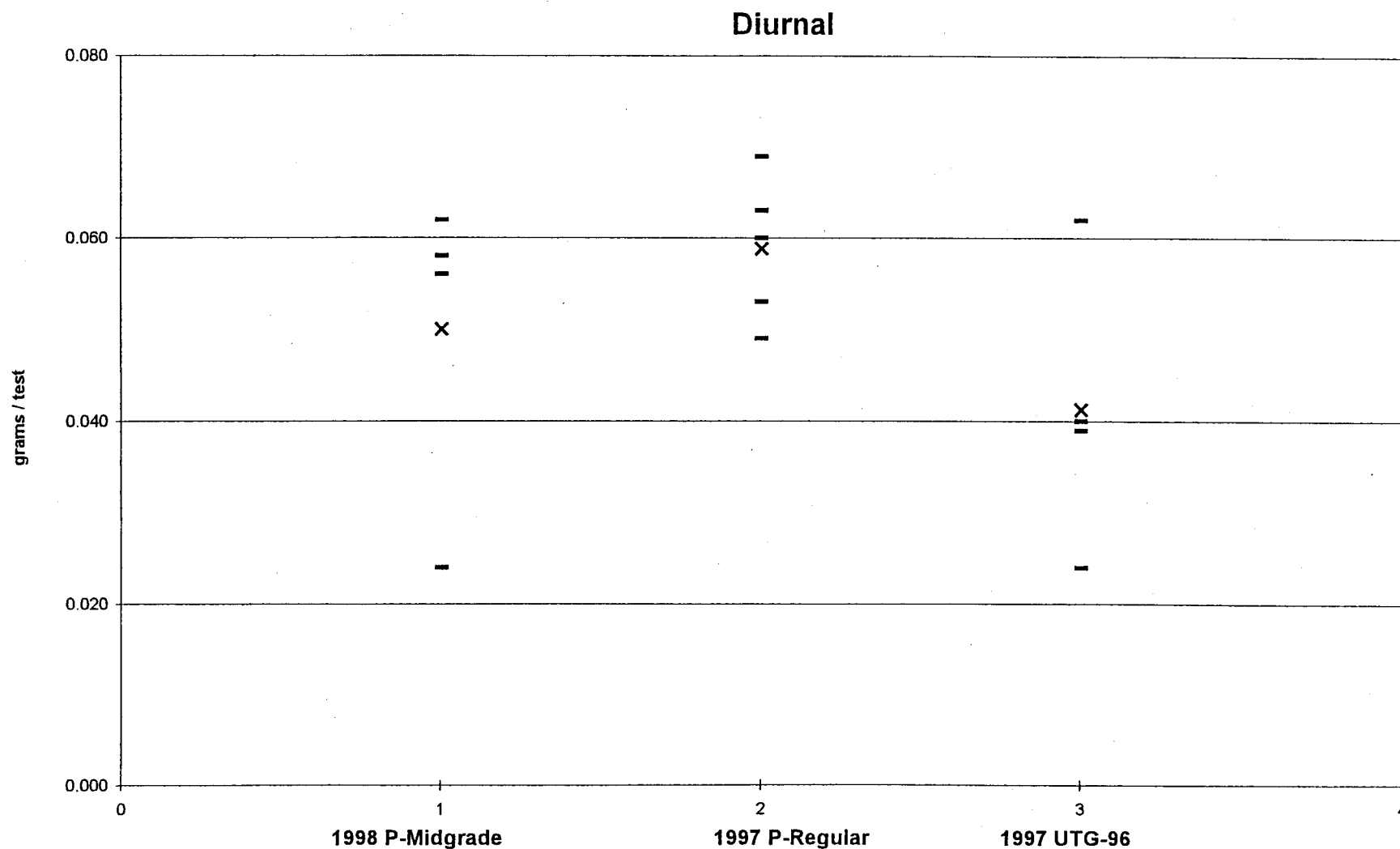
1998 Vs. 1997 Toxic Emissions -

Potency Weighted Toxics



Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and February - June 1997 on P-Series regular and UTG-96.

1998 Vs. 1997 Evaporative Emissions -

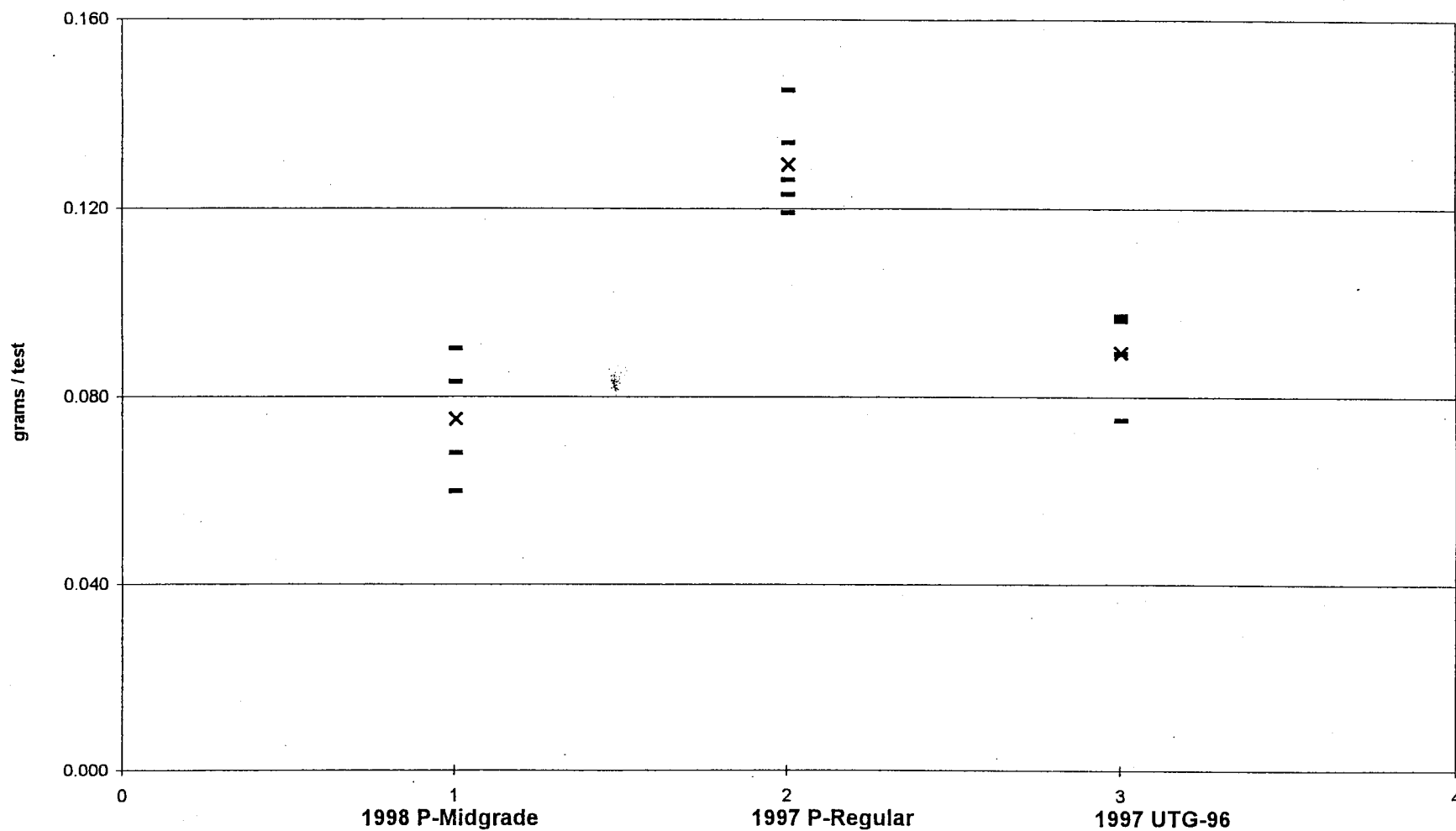


Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and February - June 1997 on P-Series regular and UTG-96.



1998 Vs. 1997 Evaporative Emissions -

Hot Soak



Tests performed on 1997 Ford Taurus E85 FFVs at Automotive Testing Laboratories, E. Liberty, Ohio, July - September 1998 on P-Series midgrade and February - June 1997 on P-Series regular and UTG-96.